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New Advertisements.

In the growth of THE ELECTRICAL WORLD in circulation, size and general improvement, the value of its columns for reaching those engaged in electrical pursuits or interested in electrical matters has not failed to be appreciated by advertisers. Readers will find it to their advantage to keep their eyes on the advertising as well as the reading columns. The following are the new advertisements in this issue: PAGE.

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Vol. XI. NEW YORK, FEB. 26, 1887. No. 9.

Two weeks ago the demands on our space compelled us to print a paper of no less than 40 pages. Last week's number consisted of 44 pages, a gain of four pages; but to-day we issue a paper of 48 pages. This is, beyond all question, by far the largest number ever published of any electrical journal. Our many friends who congratulated us on the size of the issue of Feb. 19 will be glad to see that we have risen above the high-water mark then indicated. It will be observed that the 16 reading pages are almost wholly occupied this week by the report of the meeting of the National Electric Light Association at Philadelphia. We thus, as usual, in spite of the heavy work involved, and without the slightest delay in the issuance of the paper, present a complete, authentic, trustworthy report of the meeting, in one number, making perusal and reference easy as well as convenient. It seems to us also fitting at this time to express our gratification at the pronounced and emphatic manner in which, by their pressure on our space, advertisers express their unqualified opinion as to the value of the paper as an advertising medium. Seeing that our rates are much above the average—though, of course, low when circulation and influence are taken into account—it is clearly evident that all handling electrical goods and apparatus consider that it pays better to advertise in THE ELECTRICAL WORLD than in any other paper. Our advertisements are in size and number far above the figure of last year, and are still increasing rapidly. This tells the whole story. A paper to be so highly esteemed, alike by readers and advertisers, must be independent and impartial, influential and widely circulating. The fact that THE ELECTRICAL WORLD covers the field, scientifically as well as commercially, is amply demonstrated and fully appreciated.

THE MEETING OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

We devote our reading columns this week to a report of the meeting of the National Electric Light Association at Philadelphia last week. The extent and importance of the work done were such as to warrant this step, and it will be found that our report covers everything of material interest. All the numerous papers are given, and, with but one or two exceptions, verbatim, and all the committee reports and general discussions are presented very fully. In short, the report, extending over 14 of our pages in solid type, and containing between 60,000 and 70,000 words, is the first to appear that does justice to the proceedings of the convention, presenting them as a whole and consecutively. We need hardly point out that this is the only proper and permanently useful way of dealing with the sessions of a body discussing technical, industrial and commercial matters of weight, and we are glad to know from previous experience in this matter that this method is approved by all concerned.

Coming to the work of the convention, several interesting points are to be noticed. The first is that in an arc light meeting, practically nothing was mooted in regard to the arc light itself. A great deal, however, was said in regard to the incandescent light, and it was evident that the greatest interest was felt in that department. Still, while considerable time was devoted to the question of secondary generation introduced so splendidly by Dr. Moses, little discussion occurred as to storage. The anxiety displayed in the former case was quite justifiable, but it was certainly a pity that the secondary battery was neglected. And here we may note the extraordinary fact that the convention rose without saying anything as to the lighting of railway trains by electricity. At a time when the public mind everywhere is agitated on this subject, and when electricity has proved its ability in this line, the omission was remarkable. It may be accounted for, we think, by the pressure of business already prepared.

From the papers presented by Messrs. Haskins and Weeks and the discussion thereon, it is plain that electric light men are aware that their prosperity and indeed their very existence depends upon the proper maintenance of their electric lines. No companies distributing steam in our large cities would dream of laying their pipes bare in the ground, for the loss by radiation and condensation would be enormous. Electric light and power wires present quite an analogous case, and yet, as has been shown, the need for proper insulation to prevent loss of current, especially in rainy weather, has not been fully recognized by all. When to the pecuniary loss thus entailed, we add the danger to life and property coexisting with this condition of things, it is time that the errors of the past were corrected. As President Morrison pointed out, much of the existing evil has been brought about by ruthless and shameless competition, but the remedy for the last evil is still to be sought out, and is an object for which the Association may well strive. A preliminary step to an amelioration of the present condition of things may be brought about by the labors of the committee appointed to investigate the qualities of insulated wire now in existence, but the root of the evil lies elsewhere. As Prof. Houston pointed out, the electric light can be made absolutely safe both to life and property, and the illustration cited by him, namely, the International Electrical Exhibition of 1884, leaves no doubt of the truth of this.

Prof. Houston takes tenable ground, too, when he asserts that the burying of the wires does not necessarily mean the removal of all the inconveniences connected with them in their present position. He sees a solution of the problem in nothing other than a subway, which will allow of proper separation and inspection of the wires. His idea that the cities ought to own the subways and rent them to the users is not impracticable, and, indeed, such a proposition is now before the city authorities of San Francisco. In this instance the electric companies propose that the city shall build the subway, for which bonds should be issued, the interest on which shall be guaranteed by the companies using the subway.

The report of the Legal Committee submitted by Mr. Steuart contains much that ought to be thoroughly considered by all. The recommendations of the Patent Commissioner have, as a rule, been left unconsidered by Congress, and it is evident that improvement in the present condition of the office can only be brought about by outside pressure. This was admitted long ago, but no concerted action has yet been taken in the matter. The bill prepared by the Legal Committee for submission to Congress, which provides for the appointment of a Commission of Inquiry, is the first serious step in the right direction, and we hope that the matter will be pushed with all vigor. It is probably too late to attempt anything with the present Congress, which adjourns on March 4, but at the next session and with the aid of new Congressmen, something of value to inventors may be accomplished.

Unquestionably one of the best discussions on the wire gauge question which has yet come under our notice is the report of the committee of which Mr. A. V. Garratt is chairman. After citing the pros and cons relative to the existing gauges, the committee finds them all wanting, and proposes a new gauge which is claimed to overcome the objections found in the older ones. The proposed gauge presents many good points, and is perhaps as good a linear gauge as could be devised. We hope that it may prove acceptable to the manufacturers and consumers of wire. The committee appeared to labor under a misapprehension however, in regard to the Edison gauge. From its report and the discussion which followed, it seems that the publication of it has created the impression that this gauge had been devised and put forward to be forced on general adoption. Its treatment in the report, a perfectly just one, showed that it lacked the quality of a universal gauge in its present condition. The facts of the case are, that the gauge was devised, as we understand it, for the convenience of the Edison company as such, and that its adoption by any one else is a mere matter of choice. As we stated at the time, however, the principle upon which that gauge is based is a good one. Being based upon a unit of cross-sectional area, it gives a ready means of determining resistances and weights in electrical conductors, and at the same time is equally adapted for the indication of tensile strength in iron, steel and other structural wires. Iron wire, too, has still its day of usefulness. The argument that the metrical unit of the new gauge is in conformity with the other electrical units is a good one, but if that be the case there is a slight inconsistency embodied in the recommendation that the tables (to be prepared) accompanying the gauge shall give the weights, ohms, etc., per thousand *feet*. Why not carry out the metric system in its entirety, and calculate these quantities per kilometre, adding, if need be, the values per 1,000 feet for the greater convenience of users? As the gauge stands, however, there is much in its favor. True, the metric system has not yet come into general use here, but as it is being generally taught in our schools, the rising generation will be fully prepared for it. We are not, ourselves, believers in pyramid metrology or the sacredness of the British yard, and think that some such action as the introduction of a metric gauge will be a potent factor in the permanent establishment of the metric system in this country, where it has already been legally recognized.

As was to have been expected, the motor question came to the front as one for thoughtful treatment. Mr. Baxter's paper brought out an interesting and cheering discussion, while Mr. Sprague's brilliant extemporaneous address and his rapid survey of a score of details of principle and practice will long be remembered by all who had the pleasure to listen to them. We think Mr. Sprague is right in his main idea, but we are not by any means convinced that a large amount of motor business will not be done on the arc circuits. The wires are there and the motors are available, while customers by the thousands are awaiting the introduction of the system to their notice. After all, perhaps the President hit the point when he showed how strong was the desire everywhere to develop small industries, how great were the difficulties of steam distribution and how readily every man in trade could tap power from the wire running past his door. He also suggested very wisely, and with shrewd forecast, the possibilities of a division of the lighting and motor business, and his suggestion as to forming a separate motor company, to buy its current from the lighting company, strikes us as an eminently practical way of dealing with this new question as it stands to-day.

We regretted to see Mr. Upton's admirable paper on central station construction, equipment and management receive such little attention, when it was worthy at least half a day's discussion. We were also sorry to see the theme of electrical education, to be treated by Dr. Duncan, dropped from the programme. The training of the men who do the work of the companies is a serious subject and one that is now forcing itself into notice. But taking it all in all, the meeting was one that was of the greatest benefit, and that reflects credit on the Association as a band of earnest, active, enterprising workers in the great field of electricity.

Philadelphia Meeting of the National Electric Light Association.

The fifth meeting of the Association took place last week at Philadelphia, when the following members and visitors were in attendance:

Attleboro, Mass.: H. M. Daggett, Jr.

Baltimore: W. Baxter, Jr., J. Evans, P. Keilholtz, T. McCoubray, Jr., C. R. Deacon, Dr. L. Duncan, B M. Greene, W. M. McDermott, J. F. Morrison, C. Selden, C. R. Sharretts, A. Steuart, D. H. Tuxworth.

Binghamton: J. Anderson.

Boston: W. I. Barker, S. E. Barton, C. E. Bibber, W. F. Brewster, H. B. Cram, H. H. Eustis, A. V. Garratt, H. McL. Harding, C. W. Holtzer, A. F. Mason, F. Ridlon, R. F. Ross, L. Schlegelmilch, E. S. Sears, A. F. Upton.

Bridgeport: H. L. Bancroft, H. D. Stanley.

Brooklyn: E. F. Peck, W. D. Sargent.

Buffalo, N. Y.: J. C. Weber.

Camden, N. J.: F. Reed.

Cincinnati: L. H. Weissleder, W. L. Silvey.

Cleveland: J. B. Crouse, C. P. Curtiss, W. H. Lawrence, F. B. Pettengill, J. Potter, C. D. Smith, C. L. Wright.

Chicago: W. J. Buckley, C. K. Giles, H. A. Glasier, F. W. Harrington, C. C. Haskins, J. H. Shay, F. Stewart.

E. Cambridge, Mass.: S. O. Richardson, Jr.

Elizabeth, N. J.: P. Diehl, J. G. Greene, H. W. Pope.

Easton, Md.: J. H. Covington, C. T. Wrightson.

Elgin, Ill.: Wm. Hubbard.

Erie, Pa.: F. H. Ball.

Fitchburg, Mass.: F. Fosdick.

Fort Wayne, Ind.: R. T. McDonald.

Harrisburg, Pa.: E. Mather.

Hartford, Conn.: W. M. Bond, J. A. Dalzell, H. M. Linnell, M. J. Wightman, C. G. Young.

Jamestown, N. Y.: D. H. Smith.

Kansas City: E. R. Weeks.

Lacrosse, Wis.: S. R. Montague.

North Adams, Mass.: H. E. Wetherbee.

Newark: C. O. Baker, Jr., C. McIntyre.

New Haven: F. A. Gilbert, J. Gilbert.

New York: P. C. Ackerman, J. L. Barclay, J. W. Beane, G. L. Beetle, A. W. Butterworth, W. M. Callender, W. L. Candee, D. Chalmers, H. C. Davis, J. O. Ellinger, J. P. Ford, E. F. Gennert, C. W. Gould, C. B. Hotchkiss, H. Hall, A. S. Hibbard, H. Hine, H. P. Hungerford, W. J. Johnston, J. F. Kelly, W. C. Kerr, F. E. Kinsman, H. L. Lufkin, E. T. Lynch, Jr., Geo. T. Manson, T. C. Martin, Dr. Otto A. Moses, G. M. Phelps, Jr., R. W. Pope, J. B. Powell, C. W. Price, H. A. Reed, R. W. Ryan, H. W. Spang, F. J. Sprague, F. G. Stone, C. E. Stump, C. R. Truex, J. S. Walters, Arthur K. Watt, S. S. Wheeler, J. Wetzler, G. L. Wiley, G. Worthington.

Niagara Falls: B. Rhodes.

Olneyville, Mass.: R. T. Robinson.

Philadelphia: A. Bournonville, G. W. Boyer, W. C. Bryant, H. A. Cleverly, A. J. De Camp, T. Dolan, N. H. Edgerton, H. S. Foster, H. C. Frempt, H. A. Fuller, M M. Garver, W. A. Giles, Carl Hering, S. Holbrooke, H. Horne, Prof. E. J. Houston, W. C. Johnson, M. D. Law, W. D. Marks, —— McDevitt, A. F. Moore, M. R. Muckle, Jr., E. D. Mullen, H. G. Oesterle, A. Partz, James A. Pentz, H. A. Pitcher, J. W. Queen, C. A. G. Riege, S. B. Richards, P. H. Richardson, W. M. Schlesinger, P. G. Salom, J. R. Simpson, W. E. Sharpe, A. L. Snowden, C. W. Tisdall, C. E. Trump, G A. Wilbur, J. Chester Wilson, D. T. Van Dyke, J. L. Welsh, C. M. Wilkins, E. W. Wilkins.

Pittsburgh: S. A. Duncan, Z. Latshaw, G. F. Porter, H. A. Rehan.

Portland, Me.: F. A. Sawyer.

Poughkeepsie, N. Y.: J. M. Candee.

Providence: H. N. Fenner, E. F. Phillips.

Savannah, Ga.: T. P. Keck.

Springfield, Mass.: C. A. Nichols, J. W. Hyde.

Springfield, Ill.: A. L. Ide.

St. Louis, Mo.: J. A. J. Shultz.

Tokio, Japan: Ichisuke Fujioka, M. E., S. Yashima.

Taunton, Mass.: D. L. Mitchell.

Trenton, N. J.: Fred H. Angell.

Troy, N. Y.: J. A. Powers.

Waterbury, Conn.: D. L. Hungerford.

Washington: C. J. Kintner, F. C. Royce.

Woburn, Mass.: W. R. Kimball, M. M. M. Slattery, F. Swift.

The Convention met in the hall of the Union League and was called to order shortly after noon on Feb. 15 by President Morrison, who addressed the meeting as follows:

Gentlemen of the Convention: Under the resolutions passed at the Detroit meeting, the National Electric Light Association is called in convention in this goodly city of Philadelphia.

The history of the Association shows a yearly increase in numbers, in influence and in financial standing. An exhibit of its progress ought to be a source of gratification, not only to those who have devoted their time, their money and their intelligence to this Association in Chicago in 1885, but to those who have from time to time come into its ranks to swell its numbers, extend its influence, and strengthen its financial condition. In February, 1885, at the Chicago meeting, 53 companies were represented; at the New York meeting 74 companies were represented; at the Baltimore meeting 102 companies were represented; at Detroit, 124: and to-day our muster rolls bear the names of 159 representative companies gathered from all parts of the Union. At the New York meeting the treasurer reported having received for membership fees $620, and expended $415.67. At the Baltimore meeting the collections amounted to $398.38; the expenditures $537.49, leaving a balance in hand of $860.89. At the Detroit meeting Mr. De Camp presented the report of Mr. Cooper, treasurer of the Association, which was to the effect that there was $660 in the treasury, with debts amounting, in round numbers, to $1,200; uncollected debts upon the books, $650. To-day the report of the secretary shows all the bills against the Association paid, and a balance on hand of $250.50.

Little or no improvement has been made in either arc or incandescence lighting during the past six months. The attention of investigators has been largely turned in the direction of storage batteries, but on this side of the water little or no progress seems to have been made in that direction. The foreign reports show that storage batteries have been sufficiently perfected to be used both for lighting and power; but in this country, with the exception of an installation of 500 lights in Baltimore, I know of no attempt at any extended lighting from storage batteries up to the present time. Investigation is still being pursued, however, in this direction, and I hope and believe that the next twelve months will, at least to some extent, solve the problem of electric lighting from storage batteries.

Very few accidents have occurred arising from electric lighting plants, when we consider the extent to which the service has grown. The management of the various companies throughout the country have during the last few years paid strict attention to the organization of their construction corps, so that the record for the past year closes up fairly good.

In this city it is to be regretted that, owing to defective workmanship in the running of wires in the Temple Theatre, the destruction of the building was attributed by a competent jury to that cause. This case should be written down as a danger signal by which future operations should be guarded from blunders or carelessness which might produce a like disaster. Taking the record of the year, however, we find that fewer accidents have occurred in the electric lighting business than that of almost any other industry employing a like number of men. (The President then read an extract from the paper of Mr. Henry Hine, entitled "Electricity in Its Relation to Insurance,"* read before the Electric Club of New York recently.)

The programme of proceedings was then given, and the President continued:

It is hoped that the Convention will so arrange its hours of meeting as to enable every member to be in his place, and contribute his proper share for its information. With so intelligent a body of men it is hardly necessary for me to say that each subject will be considered calmly and dispassionately, without bias and with the best judgment of the members of this Association.

The reports of the proceedings of this Association are being sought for, not only by all those engaged in the electric lighting business in this country, but many requests from those in England, France and Germany come to us for copies of our proceedings.

With the broad field of the whole world before us, with an audience not confined to those gathered within the walls of this room, but extending over this entire continent, as well as the countries just named, every word should be well weighed, every expression closely guarded, and every meaning clearly expressed before being set forth as the utterance of this Association.

One of the subjects which has engrossed the attention of the National Electric Association ever since its organization, has been that of underground wires; and in this connection Prof. Plympton, of the Brooklyn Subway Commission, has presented a most exhaustive report of his observations and investigations in Europe.† To none would a perfect system of underground wires be more welcome than to the electric light companies, and all eyes are turned toward those cities which are making experiment and investigation in that direction. The ground taken by the electric lighting men throughout the country is that, owing to the vast expense attending the placing of wires underground, they should not be compelled to adopt any ill digested plan; and that hasty legislation, until such ill digested plan had passed beyond the bounds of experiment and into the broader field of practical use, would be a great hardship, if it would not seriously cripple the industry which is yet, one may say, almost in its infancy, although 150,000 arc lights are now burning throughout the streets of this Union.

The President then introduced Mr. Thomas Dolan, president of the Philadelphia Brush Electric Light Company, who in turn introduced Col. A. L. Snowden. The latter welcomed the Convention to the city of Philadelphia in a very happy manner, and remarked, among other things, that he looked to America for the invention of the perfect storage battery by which electric lighting will be made as universal as it deserves to be.

The report of the secretary was then presented and accepted.

The report of the Legal Committee was next presented by Mr. Arthur Steuart, who announced that the Commissioner of Patents, Mr. M. V. Montgomery, had signified his intention of being present.

As the Commissioner had not yet arrived the reading of the report was postponed and that of the committee on Standard Gauge taken up and read by Mr. A. V. Garratt.

REPORT OF COMMITTEE ON STANDARD GAUGE.

Six months ago in Detroit, when, on the motion of Mr DeCamp, a committee was appointed to still further investigate and report upon the subject of a wire gauge, the first thing in regard to the new committee which struck me, was that of all the members present at that convention, I was probably the least fitted to act as chairman and represent the National Electric Light Association before the community in regard to its endeavor to simplify the dire confusion in which the wire gauge question now is.

That conviction has been growing upon me ever since then, and in rendering my report I labor under a certain embarrassment, realizing the large interests involved, and that, perhaps, if we cannot untie this Gordian knot, we may have to cut it. I shall, so far as is possible, lay aside personal opinion and prejudice and voice the opinion of this committee as a whole.

It will be remembered that at the last convention I suggested that perhaps as electric light men use wire chiefly to conduct currents of electricity a gauge might be devised the numbers of which should bear a self evident relation to the resistance of wires of those sizes, drawn from copper of commercial purity. For example, No. 4 should indicate without any calculation the resistance of a copper wire of that particular size; No. 10 the resistance of that wire, and so on. Although the idea was my own, so far as I know, and I was therefore naturally interested in it, I am frank to confess that, after a very careful consideration and much calculation, we have been obliged to abandon the idea as utterly impracticable, and right here let me say that if the report I shall make proves to be of any value to the Association, much of it will be due to the zeal of my associates, Mr. Slattery and Mr. Stanley.

Having made up our minds that we were on the wrong track, we retraced our steps and carefully considered the other gauges now in use in this country to see if by a united effort on the part of the large users of wire some present existing gauge could not be brought into universal use; realizing that even a bad gauge in general use is better than half a dozen good ones in partial use.

Without going farther into the matter I will simply say that, in the opinion of this committee, there does not seem to be much hope in this direction. I have carried on a voluminous correspondence with the large makers and users of wires, a part of which correspondence was a circular letter, which I now will read. (Here followed the reading of the letter, based on THE ELECTRICAL WORLD report, June 19, 1886.)

I am pleased to say that a very great many houses partly indorse our plan. There were, however, some objections raised, and I will here state the reply of this committee to them, before I say much about the gauge we are to recommend. The objections are as follows:

First, this Association has already adopted a gauge. Second, the Brown & Sharpe gauge is good enough. Third, the one thousandth part of an inch is good enough. Fourth, an asymptotic gauge would be the best one to adopt. Fifth, the gauge must be universal, that is, adapted to all uses of wire. Sixth, the difference in diameter between consecutive numbers of the metric gauge is too great for electric light purposes. Seventh, why not adopt the Edison gauge which has recently been published?

I think it will not be presuming to say that these questions have suggested themselves to us, and have been discussed long before they were raised as objections by others. It is evident that some of them need no answer at all; in regard to one of these objections I may say a few words to define our position on this question.

As regards the reply to the first objection, that we have already adopted a gauge, namely, the English standard, I will say that out of the many letters we have received, only one voice has raised this objection, that of Mr. W. D. Sargent, who writes as follows. (Letter read.)

Without entering into discussion as to whether we are pushing onward or retracing our steps, as the gentleman would imply, I will simply read from a letter I received from a manufacturer not far from here. (Letter from Mr. A. F. Moore read.) I am also assured by other manufacturers that they have not, since this gauge was adopted two years ago, sold a mile of wire by the English standard gauge, unless it be to this particular customer. The proof of the pudding is in the eating. Therefore your committee does not recommend the continued recognition of the English standard as the adopted gauge of this Association.

In reply to the second objection, that the Brown & Sharpe gauge is good enough, there has been but one voice seriously raised to advocate this opinion. Mr. H. B. Thayer, of the Western Electric Company, writes as follows. (Letter read.) We are inclined to agree with Mr. Thayer, in so far that we believe the Brown & Sharpe gauge is the best now in general use in this country, but we also believe that if any one is well qualified to express an opinion on this subject, it is Messrs. Brown & Sharpe themselves. I will quote from their letter. (Letter read.) When the makers and inventors of this gauge admit, of their own accord, that it has outlived its usefulness, why should we advocate its adoption? Therefore, your committee does not recommend the adoption of the Brown & Sharpe gauge by this Association.

The third objection, that the 1,000th of an inch is good enough, is the most serious objection that can be brought against our plan, and I propose to answer it here and now. And in order to do so, I must inquire whether this discussion is to establish a unit of measure, or to establish a wire gauge. If we are seeking for a unit of measure by which things of small dimensions may be accurately measured and fine working machinery constructed, then I would say with Romeo, "In delay we waste our light in vain, like lamps by day." But if we are seeking to establish a wire gauge, then the subject merits further discussion. Who among us would say that the 1,000th of an inch is not admirably adapted for the purpose of fine measurement? I have nothing to say against the 1,000th of an inch as a unit of measure for fine work. It would be foolish to attempt such an argument.

But is a unit of measure a wire gauge? What is a wire gauge? Obviously it is a series of numbers increasing in regular progression, 3, 4, 5, 6, etc., without any half numbers or any gaps in their regular progression. When applied to the size of wire, does the 1,000th of an inch meet these requirements? Most assuredly it does not. Present requirements for electric lights and power purposes call for wires varying from one 1,000th of an inch up to one-half an inch, or 500 thousandths. This means five hundred numbers. Obviously this is out of the question. Wire makers, especially wire coverers, cannot be expected to carry five hundred sizes of wire in stock, and if they did so, it would be unnecessary. Then, it may be said, carry in stock only those thousandths which are most in use, as, for example, No. 204 = No. 4. B. and S. G.; No. 162 = No. 6 B. and S. G.; No. 101 = No. 10 B. and S. G., etc. If you do that, your gauge becomes a lot of irregular numbers, very difficult for the expert to remember. For example, a wire much in use is No. 10 B. and S. G. It is 101 thousandths of an inch in diameter. But how is the whole community to remember that? Probably every house in the land engaged in covering wire has on hand a variety of covered wires of 101 thousandths of an inch in diameter. I doubt if many or even if any of them have on hand the even number, 100 thousandths of an inch, covered and packed ready for the market. It may be said: "But why not settle down to these even numbers, 50, 60, 70, 80, 90, 100, etc., and let them represent the even thousandths of an inch, and make that our gauge?" Instantly the difficulty arises that these numbers vary too much from one another. No. 90 may be too small, and number 100 may be too large for a specified purpose, and a fraction must be introduced to indicate the size required.

No! From its very nature the thousandth of an inch cannot be converted into a gauge for every day use by the whole wire-using community. Large users of wire do order in the thousandths of an inch. They are highly to be commended for so doing. But this is not the question we are here to discuss. If we understand it aright, what is wanted is not a unit of measure, but a wire gauge. Therefore your committee does not recommend this Association to adopt the thousandths of an inch as its authorized wire gauge.

In reply to the 4th objection, that an asymptotic gauge is the best one, there is but one voice here that advocates this idea, viz., Captain O. E. Michaelis, U. S. Ordnance

* THE ELECTRICAL WORLD, Feb. 12, 1887, † Jan. 1, 1887.

Department. (Letter read.) This, I take it, is a personal and unofficial statement of opinion. I quite agree with him, that it would have been gratifying if this Association could have consulted with the American Institute of Electrical Engineers on this question. It is a broad question, as he has said. The arguments in favor of and against an asymptotic gauge are many. I do not propose to enter upon them here. Their intelligent discussion would have to assume a familiarity with conic sections and the calculus, and I fear we should be using valable time without getting much nearer the object of this discussion. I think you will all agree with me, that to attempt to get the American wire users, as a class, to adopt a wire gauge, the comprehension of which presumes a working familiarity with the higher mathematics, and whose very name must ever be a stumbling block to the ordinary mechanic, is an undertaking that we may well shrink from. This must not be construed as a reflection upon the intelligence of this Association. It is simply a frank admission that we do not care to discuss fine mathematical questions in business hours.

Therefore your committee does not recommend this Association to consider the adoption of an asymptotic gauge.

In reply to the fourth objection, that the gauge must be universal, I have conversed with large wire makers, and from them I gathered that it was almost out of the question to hope for anything like co-operation from trades other than our own. In the thousand and one uses to which wire is put, the question of gauge is trifling compared with our own case. The makers of pins, or barbed wire fence will not, and cannot, be expected to take a very lively interest in the way we measure our wire. To the telephone and telegraph people, a particular gauge is more a matter of convenience than a dire necessity, as in our case. Therefore this committee does not recommend this Association to wait for co-operation.

In reply to the sixth objection, that the numbers of the proposed metric gauge vary too much, that its consecutive numbers are too far apart as to size, and in practical work one number may be found too large and the next number too small, I shall answer with a few electrical figures, which shall enable us to determine if it is really so.

As the variation in diameter increases in regular arithmetical progression, the difference in size is of course more marked between the small numbers than it is between the large sizes, for the same reason that an inch added on to a mile is not so marked as an inch added on to a foot. I shall therefore seek my illustration from rather small sizes of wire, because in regard to these the objection is more pertinent. No. 14 B. & S. gauge is a rather small number, which is much in use by electric light people; in fact, it corresponds very closely in size to the smallest number in the new Edison standard gauge. In a published account of the latter is a statement that this is "the smallest found to be mechanically and electrically efficient in the equipment of buildings with Edison conductors;" therefore it is appropriate to bring the objection against this particular size. The difference in conductivity between No. 14 B. & S. G. and its next largest size, No. 13, is about 30 per cent. of its total conductivity. The difference in conductivity between corresponding numbers of the English Standard, Stubs and the Old London Gauge is not far from the figure I have stated. The corresponding number in the Edison Standard Gauge, varies in conductivity from the next number by forty per cent. The corresponding number in the gauge which your committee is about to recommend, and against which the objection has been brought, varies in conductivity from its next larger number by only sixteen per cent. In view of these figures your committee does not recommend this Association to recognize this objection as valid against the metric gauge.

In reply to the seventh and last objection, "Why not adopt the Edison Standard Gauge, which has recently been published,"* your committee is in an embarrassing position. We trust that you will recognize the delicacy of our position, and not oblige us to discuss this gauge in regard to its national adoption. A large and powerful company has seen fit to publish a system of wire measuring which it has found convenient for its own particular uses; it has attached its own name to, and now publishes it as a candidate among the other gauges now striving for national adoption.

This is too broad a question to be treated in this way. Personally I opine, and I voice your committee in this statement, that the gauge which will eventually come into general use will not be the Brush gauge, nor the Edison gauge, nor the Thomson-Houston gauge, nor any one's else gauge. It will have to be a national gauge, independent of any particular system of lighting, or any particular company's name or patronage. Any action contrary to this would be contrary to the very spirit of this Association, contrary to our national independence of action of which we all are proud.

Realizing that there are elements of danger in the national adoption of this gauge, and not seeing merit enough in it to warrant its general use, your committee does not recommend this Association to adopt the Edison Company's gauge as its recognized standard.

The gauge which we do recommend, I will briefly describe, but will not defend, knowing right well that it needs no defense. You will remember that the chairman of your committee on wire gauge last year closed his argument by reading a letter from Mr. F. R. Welles, of Antwerp, in which a metric gauge was suggested and the statement made that generally, throughout the continent of Europe, wire was designated by a fraction or multiple of a millimetre. Mr. Pope had the foresight to himself predict that soon the same idea would take hold of the minds of men on this side of the Atlantic.

Your committee has worked the matter into shape, and the proposed gauge may be described as follows: It consists of a series of numbers from one to one hundred to represent tenths of millimetres; that is, No. 1 to equal one-tenth ($\frac{1}{10}$) millimetre, and No. 2 to equal two-tenths ($\frac{2}{10}$) millimetre, and so on. No. 1 will be about the size of 38 B. & S. Gauge, and No. 100 will be about the size of No. 0000 B. & S. Gauge. The sizes of the wire will vary about the right amount for electric light purposes. They will possess this property, viz., that the conductivities of the wires will vary directly as the squares of their diameters. For example, any workman can at once tell that No. 8 has 16 times the conductivity of No. 2 without referring to any table. I need not argue the advantages of such a gauge. Then again, the gauge unit would be of the same system as that underlying the ordinary units of electrical measurement. The volt is a metric unit, being the potential due to a unit of electricity of one centimetre, multiplied by 10^8. So it is with the dyne, the erg, the watt, the coulomb, the ampère, the farad, and the ohm. These are units that electricians use in their daily work. They are all based on the metric system. What stronger argument than this can be brought? Allow me to read the opinion of those who are expert on this subject. (Letters read.)

Your committee would then respectfully make the following report:

REPORT OF THE COMMITTEE ON WIRE GAUGE.

Your Committee on Wire Gauge report that after a careful consideration of the whole subject they recommend as follows:

1. That the British (so-called) Standard no longer be recognized as the gauge of this Association.

2. That a series of numbers from one to one hundred, each number representing the tenth of a millimetre, be adopted as a gauge, in conformity with general use in Continental Europe. This gauge will cover all numbers from No. 38 to No. 0000 B & S.

3. That this gauge come into effect in six months from the present writing or at the next convention of this Association.

4. That it be called the National Electric gauge.

5. That a committee be appointed to properly tabulate this gauge, to work out columns of figures representing the sectional areas in thousandths of a millimetre; the sectional area in thousandths of an inch; the ohms per thousand feet; the pounds per thousand feet; the ohms per feet; the nearest corresponding number on Brown & Sharpe's Gauge, and other information such as shall seem best.

6. That this committee having taken all reasonable precaution to insure the accuracy of their figures have the table electrotyped and a copy sent to every wire maker in the country, with the request that he publish it in his circular and price-list and mail a copy to his customers on the first day of next July.

7. That the members of this Association pledge themselves to purchase of a reputable gauge maker on or before the next convention of this Association, a gauge or micrometer reading in the numbers of the National Electric Gauge, at a cost not greater than that of gauges and micrometers now made to measure to the thousandths of an inch.

8. That the members of this Association offer to the committee so appointed their hearty encouragement in this not easy undertaking.

Personally I would add but a word. Let us look at this question seriously, and not rise from this session without having taken some decisive action. Let us no longer oblige our working electricians to use a crooked yardstick of no particular length.

DISCUSSION OF WIRE GAUGE REPORT.

Dr. MOSES: I am delighted to see that the matter has been referred to competent persons for consideration, and that they have embodied their ideas in such an elaborate and correct report. However, while making this change, let us be quite sure this time that we are getting something that is on the basis on which we want to calculate; that is, the resistance. That is the only element the electrician has to consider in regard to his wire. Let it be something that is interchangeable with everything else that is adopted as a scientific standard in electrical measurement. The centimetre-gramme-second is taken as the basis now of all calculations. Therefore we should have a fraction of a centimetre as a measure. But let us rather consider length than cross section: that is to say, if we take a unit of length—the metre or the millimetre, or what not—let it be a unit of length commensurate with those units that are now adopted, and we can then interchange every time without the frequent use of the extraction of the square root. As that is a matter which will require some deliberation, I think it would be well to refer this report for speedy action to the Executive Committee, who might act upon it. It is a step in the right direction. Now let us march on in the same direction.

The PRESIDENT: The committee has shown so much intelligence in its treatment of this subject, the report is so explicit and so straight, that it seems to me that it is the first committee that has fully discharged the duty imposed upon it by the Association. It has convinced me that the first step to be taken is to undo the work which was done at the Baltimore Convention; that leaves the field clear. The next thing is to continue this committee, add to it perhaps some more gentlemen, and then when the report goes out, members can read it and come to the next meeting fully prepared to discuss the question. Referring to the first recommendation of the committee, that the British Standard no longer be recognized as the gauge of this Association, the report of a committee recommending the adoption of the British Standard was adopted. Now let us see if they have adopted it. Is there a man on this floor who has carried that out in practice? If he has, let us look at him. The reason why they did not do it is that it does not fill the bill. In the shops of the concern that I am connected with in Baltimore the wires have been ordered by thousandths of an inch. I believe that that is the best system in use to-day. If a better one is provided—and I believe this is a better one—then I will guarantee—I am speaking for myself, not the Association—that we will drop the thousandths of an inch and accept the standard gauge. If the sixth recommendation of the report be carried out, it will go a long way toward making this the universal gauge, because the place to start this business is with the manufacturer. If you get the body of wire manufacturers in this country to adopt a successful method of measuring the wire, and if they do what is laid out in that report—send out to the wire users this gauge together with an explanation of why it has been adopted—there is not one man in a thousand who will cavil at its adoption. We have never before had the ground to go upon so clearly defined and backed up by so cogent reasoning as in this report. So, in my mind, if you adopt this report and add two members to the committee, at the next meeting those who will find reasons to disagree with the report will have ample opportunity on the floor to undo anything which has been done, or suggest remedies for any defects which might occur to them in this matter.

Mr. GARRATT: It occurs to me, in view of what you have said, that it would be wise to strike out that paragraph of my report in which it is suggested to authorize an electrotype of this new gauge and distribute it; and in its place I would suggest that the committee which may be appointed be authorized to print a hundred or two copies, and mail them to the leading wire users of the country, instead of going to the expense of having an electrotype made.

Mr. L. H. WEISSLEDER said that it would be unfair to the committee to adopt this report, and then at the next semi-annual meeting have the chairman ask how many have adopted this gauge, and it would, therefore, be a good plan to have all the electric light companies pledge themselves to adopt this after a reasonable length of time, and in the meantime familiarize themselves with the new gauge, and the relation of the new to the old which they have discarded, and let the transition be gradual.

Mr. EUSTIS: I want to call attention to one thing in regard to wires, and that is that in the drawing of the fine sizes there is a film formed on the outside of the wire. Now, the resistance of that film may be different from the resistance of the core. Therefore, when you take any gauge which is measured on the diameter—which, I think, is the best way to measure it—your resistance, as so tabulated, is not accurate for the smaller wires. Another point I wanted to speak about is the difference between the British Association ohm and the legal ohm, as we have it here. There is quite a difference between the two. Another question is, getting the weight per mile of wire. For the unit of specific gravity we take exactly a cubic foot of water. I have found great difficulty in getting hold of the best authority for the determination of the weight of a cubic foot of water, and also the specific gravity of copper wire. The best authorities I have found seem to point to a specific gravity of $8\frac{9}{10}$. Some of the old tables were based on 8.879, although so much smaller; so that would be a point which ought to be determined, I think, before any definite standard is taken in regard to the weights.

Mr. GARRATT: I intenionally left out of my report and my paper all considerations of the kind suggested, because I think the place for the discussion of those subjects is at the sessions of the committee. This is a business association, not a scientific body. Scientific questions are to be discussed by scientific people in their own meetings.

The PRESIDENT: Still, a reference by any member to such a subject can be carried away and used for the information of the committee. The suggestion made by Mr. Eustis is, I think, a very valuable one.

On motion of Mr. J. A. Powers, of Troy, it was agreed that four members should be added to the committee and the President then appointed Messrs. Moses, Weeks, Keilholtz, and Eustis, in addition to the old committee, Messrs. Garratt, Slattery, and Stanley.

Mr. C. C. Haskins then read a paper, entitled

"FOR HIGH INSULATION."

The electric lighting enterprise has shown to the civilized world that it has firmly planted roots, and has come to stay. It has passed the preliminary skirmishing incidental to the period of infancy; it has made for itself an honorable record as an earnest, brave combatant, and won its way through the lines of its original enemy—the illuminating gas phalanx—which now meekly holds out its hand to proffer the fraternal grip of partnership; and it numbers among its friends leaders in the army of underwriters—a force which, lacking knowledge on the subject, would accept no invitation to the christening of the new-born demon of light.

While commending and applauding the excellent results thus far attained, I trust I may be permitted to hint at a few possible opportunities which seem to me to point at substantial achievements in the future.

I would modestly, but very positively, suggest that a cheap installation, an installation which at the commencement called for a very modest amount of money; one in which drawer knobs usurped the place of the glass insulator, in which what Miller, of Cincinnati, calls undertaker's wire is strung on telephone knobs along the face of buildings; where, to reinforce the insulation through elevator shafts, under sidewalk crossings, through steam-damp rooms, etc., a wrapping of tape is rubbed down with a lick and a stick, like a postage stamp, to become, as soon as the organic oil has evaporated, of about as much value for the purposes of insulation as a molasses-covered rag; where a dozen similarly ineffectual subterfuges were used—that kind of cheap installations are in general the most expensive in the long run, if they manage to live at all. Better work in the outset is far more satisfactory to patience as well as to pocket, to dynamo man as well as to director. The use of the wire referred to for outside purposes is a loud-crying evil. In this particular direction but little progress has been made; this relic of the barbarous days of electric lighting still lives.

In a recent paper by Mr. I. N. Miller, this matter of using inside wire for outside purposes is quite thoroughly canvassed; and I wish to call particular attention to a few facts relative to the insulation of the underwriter wire when moistened. Mr. Miller says:

"Careful experiments made by immersing 12 inches of this wire in a 6 × 8 jar filled with water, the ends extending above the jar, so that the water would come in contact with the covering only, shows the following insulating properties:

	Ohms.
After 1 minute's time, resistance	115,000
" 3 " " "	4,170
" 5 " " "	1,770
" 1 hour's " "	280

"One hundred cells of battery were used in making the tests, one pole of the battery being connected with the water in the jar, the other pole with the copper conductor."

I do not believe there is any representative of a well-known electric light system present who considers an insulation of 280 ohms resistance sufficient to protect any unfortunate who grounds the line of a fair-sized arc light circuit through his body at any point in the line; or would like such a wire to rest upon his porch roof or be on terms of particular intimacy with his telephone apparatus. Yet there are hundreds of just such lines throughout this country, and they now and then get in their work; and there was a time when the makers professed to, and others did believe—on account of its name principally—that underwriter's wire was perfectly and positively safe from every standpoint of person and property. It was cheap, too, but perhaps that had nothing to do with it. We all thoroughly understand that it is the second ground which does the mischief; but in a well-soaked line of underwriter's wire the second, if not the fortieth leak, is on, and I have seen a case, not in my own bailiwick, where the deductions from rental accounts because of this wet-rag insulation, in one month, would have put kerite wire at every exposed spot, and prevented shutting down for every

*See THE ELECTRICAL WORLD, Feb. 5, 1887.

heavy rain. The use of some good form of waterproof wire, when it is necessary to run a line along the front of a building to an outside lamp, will add greatly to the general insulation of the line. It may be joined to the inferior wire—which is first-class, on porcelain knobs, for inside work—at a point inside the building where the storm cannot reach. It will cost a little more, but this expenditure will be amply repaid through the maintenance account, and assist in keeping the rental refunding account at a minimum.

Since the last meeting of this association I had the pleasure of preparing and reading a paper before the Western Association of Underwriters, on the subject of electric lighting. While there was a remarkable lack of knowledge on the subject, I did not find the gentlemen unreasonable, but, on the contrary, earnest and curious, and anxious to know something of a force of which they had but the most vague ideas: and the thought then occurred to me, that if there were a fraternal exchange of opinion between the two interests, a good fellowship created between the insurance and the electric light people, much good would be the result of the alliance. The two parties are a couple of good fellows who should be well acquainted with each other.

If, as was suggested at the January meeting of the Electric Club in New York, each of us could capture an insurance man and bring him in to discuss this matter with us—if we could educate them in this matter—I feel certain a strong point would be gained. A timid child will enter and go peacefully to sleep, in a lonely room, if a light is burning, where no persuasion would induce it to venture in the dark; and the insurance agent, no less than the general public, is nervously groping in the dark whenever he discusses the subject of electric illumination. There is still another incentive, which appeals to the sensitive electric light man's feelings, and argues potently in favor of better average insulation.

You have probably all noticed the different action of the lamps on a central plant circuit, when in the one instance the rag-wrapped wire was well soaked by summer rains, and in another instance the air was crisp and dry in the hard frozen season. The coal-pile, too, feels the effect, and so does the patron. With the mercury for a few hours in the neighborhood of zero, what was nearly no insulation becomes a matter of megohms. All electric wires show this result, from the pigmy telephone and short distance lines up to the fire alarm and long telegraph systems. In such weather, during the cold snap in January, direct telegraphing was done, not as an experiment, but as business, between Toronto and Victoria, British Columbia. This frozen condition of affairs generally along the line conserves to the wire itself all or nearly all the electrical energy which the generator furnishes for the use of the electro-magnets or the chemical solution of the receiving apparatus. Now, if the tension of the electrical pressure of a telegraph battery is capable of forcing itself away from a conductor of far more than ample capacity, to escape down a pole to ground during a rain, what are the possibilities to a dynamo current so many times more energetic both as to pressure and quantity, when its route to earth is across half an inch or so of the knob, through a soaked thread wrapping to the wet wood, iron, brick, or stone, to which it is made fast at intervals of only a few feet?

I have endeavored to show from several standpoints the necessity, as I contend, for high insulation, and I shall bring this paper to a close by offering for your consideration a suggestion which, while I am aware it is not entirely new, has one feature which I have not met with elsewhere. It is simply this: Provide your superintendent, engineer, inspector or the proper employé, by whatever name you may call him, with proper, reliable instruments for measuring the insulation resistance of your lines. In saying proper instruments, I trust no one will for a moment believe that I mean a magneto. A combination of galvanometer with twenty cells of silver chloride battery in one box and a Wheatstone bridge in another will give you an outfit with which any measuring can be done, from small fractions of an ohm up to over a megohm. Provide with the apparatus a record book, ruled for date, number of circuit, number of ohms and a large space for remarks. Let the measurements be made at least twice a week, or, still better, oftener, and the record made whether up to, or below, the standard. In the latter case, when the trouble is found, full particulars should be entered in the remarks column.

Now, if a fire occurs where there is any possibility of an electric wire having contributed to the trouble, that dumb witness, if it has been properly kept, will contribute more hard facts to ward off an unjust accusation than could be shown by your president and the entire board of directors in one long, weary day.

The discussion of Mr. Haskins' paper was postponed until after the recess, which was taken till 4 o'clock.

TUESDAY AFTERNOON SESSION.

On reassembling at 4 o'clock the discussion of Mr. C. C. Haskins' paper was taken up.

Mr. F. A. MASON: In conversation with insurance inspectors I am continually met by questions of this sort: "We do not know much about wires or about insulation, and we want to know something, and we wish that there were something authoritative we could lean on. We cannot examine different insulations, we only guess at what is the proper insulation for us to pass." It would seem to me that this is the place and that this is the time for some authoritative statement to be made, and without following with any remarks of my own I wish to offer the following resolution:

Resolved, That a commission of five members of the National Electric Light Association be appointed whose duty shall be:

First. To determine what qualities are essential to good insulation for electric light wires.

Second. To examine such insulation as may be submitted to it and to determine in what degrees the different insulations submitted possess the virtues required.

Third. To report at the next meeting of the Association the results of their investigation.

Mr. STEUART: I hope that these resolutions will be adopted and a committee will be appointed to consider this question. It is one of the most important subjects connected with electric lighting that we have to deal with, as I had the honor to point out at the Detroit meeting as chairman of the legal committee. It has a very important bearing in consequence of the fact that the relations which exist between electric light companies and the public, and between electric light companies and insurance companies, are almost entirely due to the condition of these wires. The legal question as to whether an electric light company is responsible for the damage caused by fire or the damage caused by the loss of life will be dependent upon the answer to this very question when a case comes to be tried for such an accident, should it occur, and the companies were to be brought into court under it. The condition of the wires will determine the question of the responsibility of the company, and if it be thoroughly proven that it was within the power of the company to have their wires in a perfectly good and safe condition, and it be further proven that they were not in that condition, and that the accident resulted from that cause, the electric light company will be held in damages, and be made to pay them. Whether it be a loss from fire, or whether it be a loss of life, they will be held responsible for the damages, and they should be. Therefore, I think it is a very important matter for this committee to be appointed and that this Association should take broad and decided ground with reference to the character of the insulation, the insulators that should be used by its members, as well as by those who are outside. Give the insurance companies and give the public to understand that this Association has taken a stand before them in which they pretend to say, and propose to say, that they are giving to it the right thing and that they are going to give the members the opportunity of having a committee determine whether they are doing the right thing. Then it will stand in a proper position before the public, and they will gain the confidence of the public. For that reason I think this committee should be appointed and I think it will be.

Prof. HOUSTON: I was not present at the meeting this morning when the paper under discussion was read. I simply rise to ask whether the discussion related entirely to the subject of insulation and insulating power? It seems to me that an electric light wire to be safe should possess three properties. Unfortunately, the three properties would be very difficult to be found associated together in the same wire. It should not only possess high insulation, but it should be impervious to water or moisture, and should be incombustible. Whether or not these properties can all be found in one and the same conductor I am unable to say, but when that conductor is found that possesses this threefold group of properties, I am sure the best conductor will be found for economy and safety in working. I simply rose to ask the question whether under the head of insulating power the other two equally important requisites, impermeabilty to water and incombustibility have been considered?

Mr. L. H. WEISSLEDER: Before the subject shall receive the sanction of this Association there should be be an amendment. I think it would be a good thing to have it qualified, as under some circumstances there would be a great loss entailed in the rearrangement of wires and great loss to property, amounting to the confiscation of some plants running on a very small margin. And another thing; the gentleman who has just preceded me was speaking about insulators and a fire-proof covering at the same time. I might say that a wire thoroughly insulated does not affect the ground line or produce fire, because the fires produced have generally been in wet weather, and we have found in our own business in running into buildings, that sometimes the current would escape from the wet wood and produce a little conflagration and some damage. A great many complaints have arisen from this. A good many companies are equipped with good wires for ordinary weather, but if the wire were run against the iron cornice or a roof it might produce an escape and be unsafe to property, and manifestly a fire might occur.

Prof. HOUSTON: It is true that a wire well insulated originally may from moisture become a source of danger from fire, and might not be the cause of fire itself. But it is not true that the wire is free from danger as an incendiary; that is, the covering acting as an incendiary. A very serious fire is likely to occur on the outside of the wire itself. Surely, in a practical meeting like this, it must be well known to members that there are wires which, if inclined upward a little and touched at one end by a match, will shoot forth a column of flame almost as rapidly as a man can walk; there comes the danger. When my duties led me to inspect the circuits at the International Electrical Exhibition, of which I was the electrician, I remember very distinctly that we had to guard very carefully against wires of a readily ignitable type, and many a time have I tested wires from which the flame would run from one end to the other almost as rapidly as a man would walk. The trouble with such wires would be in danger from the current which traverses it carrying fire from one part of the building to another.

Mr. CALLENDER: I move as an amendment to the resolution that the first and second objects be kept in view, and that the third be left out. It seems to me that the object of the committee should be to investigate the question of what insulation is necessary, and that it should not be to determine what kind of insulator should be used, any more than a committee should be appointed to examine into which kind of dynamo is best, or which kind of lamp should be used. The object of the inquiry is one of very great importance, and its importance is growing day by day and being recognized by electric light companies; if the second and third part be left out, it seems to me the resolution would then cover all the points that should be investigated by this association.

Mr. MASON: I introduced these resolutions at the suggestion of a number of insurance inspectors, who said that they were not able to determine these questions; they had not time to investigate; they were obliged to pass upon installations; they were obliged to say whether they would or would not pass and use certain wires, and it seems to me that it does lie in the purview of this Association to determine what are the needed qualities in the first place. I do not need to go on and mention that there are other qualities not in the way in a good insulation, but the gentleman who spoke a few moments ago on the legal aspects of the question made a very comprehensive point. Those of us who own installations and who are connected with electric light companies wish to be protected and we are not protected to-day. I have the misfortune to be connected not alone with an electric lighting company, but also with a wire interest; but I speak now in connection with the first interest. We want to know whether we are protected against suits from telephone and telegraph companies and from private individuals if we have taken all due pains and precautions.

On being put to a vote Mr. Callender's amendment was lost and the original resolution carried.

The committee of five provided for in the resolution was then appointed by the chair, as follows: Prof. E. J. Houston, M. M. Garver, R. T. Robinson, Carl Hering and Prof. W. D. Marks.

Mr. E. R. Weeks then read a paper entitled:

POPULAR PREJUDICE AGAINST ELECTRIC LIGHT WIRES.

The long line of martyrs to newly discovered facts gives ample proof of the tendency of man to adhere to the old, and fear and reject the new. Even in this nineteenth century of progress, when invention presses on invention, discovery on discovery, the latest and one of the greatest discoveries feels the impulse of doubt and opposition and popular prejudice, the old summation of ignorance cries out against the electric light.

It is true that the superiority of the illuminating properties of electricity has brought about its use to a remarkable extent, yet the prejudice against the methods of general distribution bids fair not only to hinder its widespread adoption, but to result in legislation that may retard our industry or burden it so heavily that the small beginnings upon which we must depend for the general diffusion of electric light, will be prevented by the great cost of construction and maintenance.

It behooves us then to inquire into the causes of this prejudice and to discover its remedy. It must be admitted that there is an element of danger connected with our business. But the same is true of all modern devices that have materially assisted progress. Now that we fully comprehend the power of steam, we can only wonder that its applications met with no more opposition than they did. But every one thought he knew what steam was, while electricity is an unknown invisible agent, which the popular mind holds in awe, nearly akin to that which led the ancients to propitiate the God of thunder.

The element of danger is, therefore, magnified to vast proportions, and this result, combined with another ignorance of the nature and laws of electricity, makes a strong case against a force in regard to which the wisest have much to learn.

To realize the feeling of the public toward this industry, consider our chances as dependent before a jury in an action for damages to life, limb or property. Were the jury chosen even from the average of intelligence, instead of from the usual stratum, the chances of a verdict for defendant would be but one in ten thousand, though all the expert testimony were clearly against the plaintiff.

Again, this element of danger has been increased by careless workmanship and negligent maintenance. Unavoidable ignorance of the best methods of managing machinery, running lines, etc., has led to much unsatisfactory service and some loss of life and property, though in an insignificant proportion when compared with that which attended the early history of gas and steam. But these causes can no longer be pleaded as an ample excuse, for, although no system of electric lighting has attained perfection, the safest and most efficient methods of construction are well known, and the poor workmanship seen in the lines in many of our cities, the temporizing resorts and money-saving devices in an industry that needs perfection in all its parts, prove that complaints against us are not wholly without foundation.

Much of the popular prejudice against electric lighting apparatus is the outgrowth of the opposition that this branch of electric industry has met with from gas interests, and in quarters from which we had reason to expect a most kindly welcome and considerate treatment. It is true that light wires conveying currents of high tension, or enormous quantity, are not very desirable neighbors for either telephone or telegraph lines, but the commodity they carry is just as valuable to commerce, and to the convenience of the public, and has the same right to existence and to accommodation, as have the "great conversers" of the present age. It might seem strange that we have met with such opposition and unkind treatment from our cousins in these kindred industries. Yet from time to time we find newspaper articles and reportorial interviews with telegraph and telephone men, the reliability and animus of which may be judged by the following extract from an interview with a prominent telephone manager not many thousand miles from Detroit:

"How about electric lights?" "Well that is a different thing.

"The arc circuit, in which the most brilliant lights are placed, is a constant danger when the lights are burning. There is present in the wire itself sufficient electricity to kill any man. You don't have to wait for lightning to come along. The lightning is there. Many a lamp trimmer rues the day, and the chance for paralysis of the man who handles electric lights are a thousand to one. In the case of a man who handles telephones? Yes, there have been a number of fatal cases in that line of business. I know one man who used to trim the lights on top of the 150 foot mast in Union square, New York. One day he was trimming the lamps, and some people who were watching him saw him topple over and fall to the ground.

"It was not a mismove; it was a let go. Well, the company said he had heart disease, or a fit; but it was just electricity that killed him. I think, though, that the greatest danger is in case of a fire. I have known a number of firemen to be knocked down and quite severely hurt at fires by the electricity from the electric light wires. The fireman may be holding the brass nozzle of a hose, and the water may be striking a wire through which a strong current is passing. Presently the wire breaks, or some one turns off the electricity, and the current will run down the stream of water and pass through the body of the fireman, and perhaps seriously injure him. These conditions are not unusual at a fire, and are impossible for a fireman to guard against. It is really far more important that electric light wires should be put under ground than either telegraph or telephone wires. It would interfere far less with the former business than with either of the latter."

Such a tissue of mis-statements and rank ignorance seems to those who know the truth to need no refutation. But the masses have no technical knowledge by which to judge of the utter falsity and absurdity of the whole thing, and therefore the result in forming public opinion is highly prejudicial to our interests; for people are willing to have their fears fed by those who will.

If these are some of the chief causes that have led to the popular prejudice against electric light lines the remedy is plain.

Let there be better construction in putting up poles and in running wires. Let there be a rigorous exclusion of all makeshift devices. Let the entrances to buildings be made in the neatest, most inconspicuous, and above all safest way.

Let grounds and crosses be rendered impossible, except

under circumstances beyond human control. Maintenance should be looked after with such vigilance that the evils attendant upon the necessary crudity of much of our apparatus be reduced to a minimum.

A thorough system of inspection should be instituted in order to quickly detect and correct trouble; complaints from any quarter should be patiently heard and the causes removed as soon as possible; in other words, by the best construction, by ready, constant and obliging attention, we should seek to render the unavoidable imperfections of service and immaturity of our apparatus less apparent.

One of the most weighty causes of prejudice would be done away with if a more fraternal spirit among the various electric industries would be created. All should work together for the common good. Each adaptation of electricity has its special needs, which every other is bound to respect, and nothing is gained by attempts to exclude or hamper any one of them. Each is necessary for the present, and each is here to stay. Each has its own weakness which can neither be hidden nor cured by attacks on the others.

The members of this association may accomplish much in one direction, at least, and that by working for the enlightenment of the general public as to the agent we employ. Only through such enlightenment can we hope for justice, either in the courts or at the bar of public opinion.

As people more fully understand the character and usefulness of this force, its channels of operation, how perfectly it may be controlled, and the many advantages of its adaptations for lighting, most of the prejudice against it will disappear.

The telegraph and telephone industries have been fully explained to the public in popular treatises; but we have been somewhat remiss in this respect. The promoters of electric lighting have been so occupied in introducing their apparatus that they have confined their writings to technical journals, and have left the instruction of the public to such teachers as the one above quoted.

DISCUSSION.

The PRESIDENT: While Mr. Weeks was reading his paper, this question occurred to me. What makes cheap work possible? Two things, sharp competition and bad pay. When you put in the field in competition three or four electric lighting companies, instead of endeavoring to bring about a good service which will pay a fair profit, an effort is made in the direction of obtaining the contract at any price almost, whether there be profit in it or not. Now, what is the result? All this follows that Mr. Haskins suggests. Among well ordered electric light companies you will find that the cost of installation is much higher than those where helter-skelter methods were adopted in the early days of the business. They make the electric lights at the cost of forty cents, and they are compelled to serve corporations because corporations will have electric lights. It has passed now beyond the point of experiment; it is recognized that electric lighting is the only method by which streets can be properly lighted; and the corporation seeks to get the lowest price without going into an intelligent examination of the details by which the company shall accomplish that lighting. Therefore, the company will offer to light the streets for fifty-four cents, and I think that they have offered lower than that when they knew, and we know, that it is impossible for them to make and deliver the light at fifty-four cents and receive any profit therefrom.

Not only do they lose the business themselves, but by this sort of competition they injure the business and the interest of the electric lighting companies who put up the capital and enter the business as a bona fide industry in that locality. Now, there is a disease; I do not know the remedy. We have endeavored to apply it at every Association meeting. So far as I have been able to see and recognize it, I have not only used this organization but other organizations to prevent this sort of work where I have been interested. The demand for cheap shoes gives rheumatism; the demand for cheap shoes gives people consumption, and the demand for this sort of thing where men are not judges of the quality of work brings about all the evils of the commercial world, and brings about many of the evils for which you call the doctor, and many of the evils which call for you to bury the poor electric wires, when it is not the electric wires at all, but it is the parent company producing unfair competition in various localities.

The secretary then read a pamphlet prepared by Mr. S. E. Barton, of the New England Insurance Exchange, relating to the subject under discussion. The pamphlet showed that when properly inspected, electric lighting plants are considered by the Exchange the safest of all illumination.

Prof. HOUSTON: Those of us who have traced the progress of electric lighting, know that during almost every decade from some time in 1810 there had been the appearance of the electric light promised, and great things blossomed for a while and drooped. But at this time we may say that electric lighting has come to stay. It has come to stay because to-day it stands without any rival as a general artificial illuminant. It is better because it is more like sunlight; it gives a more general illumination; it is less fatiguing to the eye; it is better from a hygienic standpoint; it does not poison the air of the rooms, and I take also the stand that it is better because it is more reliable and safer than any known illuminant. It is safer to both life and property. When we contrast the electric light with the old torch; when we contrast it with the tallow candle, the coal oil lamp and the gas jet which have successively replaced one another, I think that we can all agree that, contrasted with them, it stands number one, head and shoulders above any one of them on the score of safety to both life and property. Our insurance friends will correct me if I am wrong when I say that the friction match which the electric light entirely replaces, or the uncovered gas jet, or the explosive and easily overturned coal oil lamp have been a greater destruction to both life and property during the last year than the electric light; and yet the electric light is a child of comparatively few years of age and other systems of artifical illuminations have been in use for a long time. Of course we must recognize that the electric light possesses dangers; that it will kill if one is stupid enough to permit the current to pass through his body. It will also ignite combustible materials if it is improperly placed. But I assert, and I think you will all agree with me, that there is no necessity in properly constructed systems of electric lighting, of either the people taking the current through their bodies or of combustible materials coming within reach of the electric currents. I know from practical experience that electric lighting can be made safe. This was tested and exemplified at the International Electrical Exhibition. We did not adopt the rigid rules adopted in England and yet in a frame building we had innumerable circuits containing three thousand volts of electromotive force, and thronged with visitors, and neither was the building burned nor was there any loss of life. So we can testify that the electric light is safe. I think we should insist upon the fullest degree of inspection that our insurance friends can ask, as it is our only safety. We are not running a system that we need fear the most careful inspection of, if we only could agree among ourselves to put in the very best work, use only the very best materials, adopt freely all the well-known and well-tried danger preventives, either from fire or from loss of life, and then I do not think we need fear what the future may have in store for us. I do not think by any means that the dangers will be all removed when the electric wires are all put under ground. On the contrary, as the result of very careful thought, I am confident that the time will come when from expansion or leakage, oxidation or an earthquake, or when the sewer gas escapes, and this will always take place more or less, and you cannot keep it out, then it will inevitably some day bring about contacts, and then they will be contacts of the most glorious character! Contacts that may at a moment reach different and widely separated parts of the city and place them in danger. I do not think that the problem is going to be solved as easily as many of our friends seem to think. Out of sight, out of mind. Therefore, I cannot agree with the conclusions when it is urged or hoped that the time will come when all the wires will be under ground. I suppose the time will come, and must come necessarily, when all the electric wires will go under ground, but I do not think anything has been shown of a scientific character which proves that the system has been perfected whereby we can safely go under ground. It seems to me that it cannot be successfully done with a conduit, but you must have a subway. When you have that the question of the under ground-wires will be settled. I only wish to say one thing else. It has often been remarked by people coming from England and other countries that America had made great progress in lighting, more, probably, than any other country in the world, and it is for the very simple reason that, thus far, the electric lighting companies have been let alone and have not had their hands tied, and restrictions have not been thrown around them. But if the laws which prevail in England in reference to the matter are enforced here, then the progress of arc lighting in this country will be barred. I cannot agree with the statement as to its being unquestionably true that converters are necessarily dangerous; or that high tension electric light circuits are necessarily dangerous. They are more dangerous than others unquestionably; the question is whether they can be so regulated, whether such safeguards can be thrown around them as will render it advisable for us to use them. I think such safeguards can be. Now, only one other point; if a law should be attempted to be passed in this country limiting the electromotive force to two or three hundred volts, on the score that a higher electromotive force than that would be dangerous to life, I think we all ought to be ready to answer that question, which seems to be a very difficult one for people who wish to introduce such restrictions to answer. And that is, I doubt very much whether a person taking the electric light current is killed as a result of the current normally generated by the machine passing through his body, but that which kills him is most probably the spark produced on breaking the current contact. Again and again we read of people who turn pale, shiver and all that, and then at the moment the wire is broken fall down as dead. Why? Because if a machine capable of giving only a few hundred volts has the circuit suddenly broken, there is produced a current of several thousand volts. If that be true you do not gain any advantage when you limit the electromotive force to two hundred volts. You do not make it perfectly safe, but of course it is safer than otherwise.

Dr. MOSES drew attention to the fact that provision ought to be made by which a 32 c. p. lamp could not possibly be put in a 16 c. p. lamp socket, as the increased current would heat the wires dangerously. The remedy would be to put a safety catch in each lamp socket.

The President then announced the subject for the next day's meeting, and the convention adjourned for the day.

During the session a letter of invitation was read from Dr. W. H. Wahl, secretary of the Franklin Institute, asking the members of the Association to attend its regular monthly meeting on the following evening, and on motion of Dr. Moses, the invitation was accepted.

Mr. De Camp also invited the members to visit the Brush Electric Light station of Philadelphia.

WEDNESDAY MORNING SESSION.

After the convention had been called to order, the Secretary read a communication from the Electric Club, of New York, stating that the following resolution had been adopted by the club:

Resolved, That the president of this club appoint a committee of five, including the president, to confer with the committee that may be appointed by the National Electric Light Association, to consider the question of uniform rules and regulations to govern the installation of electric light plants; that these committees be requested to confer with the representative underwriters, and that they be solicited to take measures authorizing the appointment of a committee for the consideration of this matter with the committees above named, and that a report will be expected from this committee at the next regular meeting of the club, March 3.

The following committee had been appointed by the club: Mr. Geo. W. Hebard, President of the United States Electric Lighting Company; Mr. Geo. W. Stockly, President of the Brush Company; Mr. T. A. Edison, of the Edison Company; Mr. N. T. Pulsifer, of the Mather Electric Company, and the President of the Electric Club, Mr. H. C. Davis, of the Sawyer-Man Company.

The communication was referred to the committee named in Tuesday's report—Professor Houston, President

Mr. STEUART, chairman of the legal committee, submitted the following report on

REFORMS IN THE PATENT SYSTEM.

At the last meeting of the Association in Detroit, your committee reported several important reforms that were required in the Patent Office and in the administration of the patent system. And it was resolved that the committee prepare and present to this meeting bills to be presented to Congress which would provide for the reforms which were considered expedient.

A short review of those reforms may be in place here. The present law of the United States is substantially identical with that passed by Congress in 1836. For half a century we have been working under a law excellent in its general nature and intention, but sorely defective in many of its details. During the year 1837 there were issued by the United States Patent Office 435 patents for inventions, while the salaries of the officers employed aggregated $6,850. This was the extent of the business which existed at the time of the passage of this act and for which it was intended to provide. During the year 1886, there were issued by the Patent Office 25,619 patents, while the aggregate salaries of the persons employed has reached the sum of $650,000.

A simple comparison of these figures will how at a glance how utterly impossible it is that a system established fifty years ago for the conduct of a business represented by an issue of 435 patents per annum, and which has been changed only by the addition of a greater force as such became necessary, can be suitable for, or cope with, the questions that present themselves daily, in handling so large a mass of business as is now transacted by the office. An average of 448 patents are issued every week; more than at the date of the passage of this law were issued in a whole year.

It is easy, therefore, to appreciate how difficulties have arisen that were not contemplated by the Commission that prepared this law. Many things have changed in the interval, and while the office has run along with moderate smoothness, the time has come when the importance of the subject demands the attention of Congress. It only remains for those as deeply interested as we are to knock long and loud at the doors of Congress until we succeed in bringing its attention to the subject.

The last report of the Commissioner of Patents, filed with Congress only two days ago, points out with definiteness the reforms that are needful.

LABORATORY.

The members of this association, as I mentioned at the Detroit meeting, are most deeply interested in the erection of a laboratory to be devoted in great measure to electrical experiments for the purpose of testing appliances upon which patents are sought. Scarcely a member of this association who has been before the Patent Office with an application in this field has not felt the great demand for facilities of this character, and the commissioner urges its importance in his report.

EMPLOYEES.

The nature of the service to the public expected of examiners in the Patent Office requires that they should be men of such high attainments as to be able to give a thorough and intelligent examination to every invention presented for a patent; in order that the rights of the public may be protected and also that a patentee may not be deluded by being giving a patent on a device which, when it comes to be tested in the courts, is found to be worthless. To accomplish this result it is necessary to pay the examiners salaries high enough to justify good men in making the service of the office a profession, to which they will devote themselves, and expect to make it their life work.

PATENT OFFICE COURT.

I may be pardoned for quoting the commissioner upon the most important subject for your consideration. He says:

"In my last annual report the following statement was made. 'At the present time, in addition to his administrative duties, the commissioner is called upon to hear all cases of appeal from the rejection of a patent by the examiners-in-chief, as well as to finally hear and determine all interference cases which may be appealed to him. Aside from the burden which this imposes upon the head of this office, there is a want of uniformity in the decisions which emanate from time to time from the respective Commissioners of Patents which ought to be corrected. I know of no better way to correct this evil than the establishment of some tribunal, to consist of at least three judges, whose tenure of office shall be fixed, and to whom all appeals shall lie. I have no doubt that the establishment of such a tribunal with such jurisdiction would not only make it possible for the commissioner to conduct a more successful administration of his office, but would secure to inventors and to the public a much more intelligent and uniform exposition of the law of patents and of the important questions which now of necessity must be determined so hastily.'

"I again invite attention to this subject for the purpose of asserting that my experience of the year last past has not only confirmed me in the views which I then expressed, but has made much more manifest to me the necessity for some legislation of this character. A court of sufficient dignity and strength ought to be created, and such tribunal might very properly be invested with final jurisdiction in all matters pertaining to the patentability of an alleged invention as well as all matters of interference between litigating applicants. Such a court with such a jurisdiction would not only result in leaving the commissioner free to attend to the other pressing duties of his office, but would inevitably relieve the federal courts of much of the litigation upon these subjects with which they are now burdened.'

Here is the deliberate judgment of the man best fitted to judge of the needs of the office and the changes that would accomplish the results desired. A court such as that suggested by the commissioner would have the effect:

1. Of making the practice of the Patent Office uniform and logical, and those of you who have much business with the office know how great a gain that will be.

2. It will merge in one tribunal that will never die or go out of office, the decision of all the questions now passed upon by the Commissioner of Patents, the Examiner of Interferences, and the Board of Examiners in Chief, and as a result we may expect to get uniformity and a logical connection in its rulings upon subjects closely related, but now passed upon by several different officers.

3. The decisions of such a court, if made co-equal with the Circuit Courts of the United States, would be readjudicated whenever called up in them, thus relieving those courts of the necessity of examining into questions of patentability when they arise in the trial of patent cases.

4. It might also be well to give this court original jurisdiction in cases for infringement of patents. Such a court would offer to all those who came before it the inestimable advantage of a knowledge of, and interest in, patents which would insure to the patentee an intelligent hearing

and a disposition to give him all that he was entitled to under his patent.

COMMISSION.

The next question to be considered is, how are these results to be accomplished. It is very difficult, as we all know, to persuade Congress that the measures that commend themselves to our minds as desirable will either meet with the approval or accomplish the results that others equally as intelligent and interested as ourselves may have in view.

I think the Commissioner of Patents has suggested the proper course when he says in concluding his report:

"I feel so confident that changes and modifications too numerous to be dwelt upon in detail, or to be pointed out in this report, of a substantial character which would materially effect the prosperity and usefulness of this office entire, are imperatively needed, that I cannot refrain from concluding by again urging upon Congress the necessity of providing in some way, by commission or otherwise, for a complete and exhaustive revision of the entire legislation and probably of the rules which affect this office."

The surest road to the results we have in view would be the appointment of a commission by Congress to examine the whole patent system as it is at present, both the branch under which patents are granted, that is to say, the Patent Office, and that under which patents are litigated and rights under them determined by the courts, and to report to Congress an act, that will provide for changes as this commission shall find necessary and desirable. Such a commission created by Congress and appointed by the President could give to the subject a most full and intelligent consideration, and when their report was formulated into an act it would without doubt be passed as they prepared it. We could feel that we had a law commensurate with the development of the subject, and one that would successfully and satisfactorily cope with it.

I have prepared a bill to be presented to Congress which provides for the creation of such a commission, and it remains with you to adopt it here, and then urge it upon the attention of Congress with sufficient earnestness to secure its passage. The present Congress goes out of existence on the 4th of March, and before that time it must be pushed through both houses if it is to become a law. It is very desirable that this commission should be appointed at this session in order that its report may be submitted to the next Congress.

The bill will be filed at once and each member of the Association is earnestly requested to take the matter up and use all the power at his command to urge its passage upon the members of the Senate and House of Representatives.

PATENTS, TRADE-MARKS AND COPYRIGHTS.

A Bill

Creating a Commission to examine and report to Congress needful reforms in the patent system.

Whereas the patent, trade-mark and copyright laws of the United States are deemed to be in such a condition as to require revision, therefore;

Be it enacted by the Senate and House of Representatives of the United States in Congress assembled:

Sec. 1. That a Commission be and the same is hereby created, to consist of three suitable persons to be appointed by the President of the United States, who shall hold office until a final report of this Commission is submitted to and accepted by Congress. And who shall receive for their services a compensation of $5,000 each per annum.

Sec. 2. It shall be the duty of this Commission to examine thoroughly the present Patent, Trade-Mark and Copyright laws of the United States, and those of other countries, and their practical operation and effect in meeting the needs of the public, and fulfilling the purposes for which they were created. To formulate a report to be submitted to the next Congress, which shall set forth the results of this investigation, and their conclusions therefrom, with reference to changes in or additions to the present law, pertaining to patents, trade-marks and copyrights. This report shall also contain a draft of an act which will provide for the changes found necessary by investigations of the Commission.

Sec. 3. The Commission is authorized to employ such clerical force as may be necessary for the proper conduct of its work, and to incur such other expenses for stationary, printing, etc., as may be found expedient.

Sec. 4. The salaries of the members of this commission, as well as all expenses legitimately incident to its work, shall be paid from the surplus in the United States Treasury to the credit of the Patent Office.

All expenditures by or for said commission, other than the salaries of the members shall, however, be under the control of, and authorized by, the Secretary of the Interior.

Mr. STEUART read a telegram from the Hon. M. V. Montgomery, Commissioner of Patents, expressing that official's regret at being unable to be present.

A letter was read from the Edgerton Motor Company, inviting the members of the Convention to visit the establishment of the company.

Mr. J. H. SHAY then read the following paper on

TRANSMISSION OF POWER BY BELTING.

The transmission of power from its origin at the driving wheel to the receiving pulley or shaft originated as nearly all mechanical appliances have had their birth, in a necessity, and in their first existence such creations have always been crude and imperfect. Thus we see in ancient pictures that strips of rawhide were used, more or less twisted, perhaps, but with huge and ungainly knots where the ends of the pieces are connected. From this an advance was made when cordage of imperfect construction became common, a lineal descendant of the twisted thong or a flat, untanned strip, or series of strips, of rawhide were connected by every conceivable form of knot or other awkward connection.

The time which elapsed before any reasonably fair belting made its appearance may be counted by scores of years, and during that long period, of all the various devices the most satisfactory had proven to be a tanned leather belt.

Still the users of belts were not happy over the results obtained, and a radical innovation was made when an iron wire cable or rope made a stir for a comparatively short time, yet except for special purposes it has found little favor. A few of the more serious objections to a wire rope are perhaps worth bare mention.

Constant use as a belt will, in a comparatively short time, crystallize and render the wire brittle, when it will of course refuse to bear the strain, and gradually give way.

The repairing of a broken wire cable belt is extremely difficult, and the mended portion is never of the same diameter as before. When it commences to fail it is but a short time until its ruin is complete; and, lastly, no round belt has bearing enough to do perfect work where solid hard labor is required of it, and the wire belting is no better than any other round belt on that account. Other methods of transmitting power by gearing, etc., had their day, but these have gone out of use, and there is nothing to be gained by discussing these noisy methods. For the past half century these have been gradually disappearing from view, until we have to search for an existing example outside the industrial centres of the world. The verdict of the mechanical engineer everywhere when called to sit in judgment on this question is the same: "There is nothing like leather."

Yet there are as many kinds and forms of leather as there are of nearly any other animal product and while for some purposes we know other leathers are better suited, the fact is undeniable that for strength, durability, ease of repair, and adhesion oak-tanned leather captures the blue ribbon and stands superior to any others on all occassions. The first essential is found in the character of the hide; due care must be exercised in the tannage, and a thorough and careful selection of hides must be made to insure evenness of stock. Without particular pains in this last requisite uniformity in the belt is impossible. Or the stock must be reduced to a uniform thickness by splitting, which introduces another fault, weakness, and consequent want of durabilty.

Having now arrived at the point when the properly selected, tanned and sorted stock is ready for cutting and splicing, we have to decide which of several methods is best for attaching the various lengths to form a continuous belt.

There are, as I have intimated, several methods of attaching these.

By thongs of lace leather.

By wire hooks.

By rivets and burrs.

And finally by scarfing and lapping—the two scarfed surfaces being cementeo under pressure. This has been adopted quite generally by Western manufacturers, and any objection to such joints which may have formerly existed are now set at rest forever through the use of more recent methods and materials. There are objections to the three methods first mentioned which are at once simple and damaging, from a mechanical point of view. It goes without saying that a belt punched full of holes for either lacing, hooks, rivets or any other appliances for fastening is weakest at those splices, instead of being strongest. And again, any inequality, such as must necessarily arise from any one of these fastenings, must result in undue strain on the belt, must give rise to a slapping motion, and thereby reduce the useful work of the power. We may find a still more serious objection further along.

When an important belt is properly constructed, properly proportioned and speeded, and receives the attention and care which it deserves, there is scarcely any limit to its durability, The cause of the failure of many large belts may too often be found in some one of the above particulars. Of course, there are other things to be considered. It is a mistake to figure too closely on the length or width of an important belt. Do not risk a possibility of slipping, which means heat and will ruin the best belt made, in an astonishingly short time. It was a few years since the rule among one class of belt customers to depend almost exclusively on rubber for the severe work required in saw-mills. This has now fallen into disuse, and has been replaced by leather, this latter proving better adapted for this purpose.

Belting for electric light machinery, to be a success, must have characteristics not necessarily found in belting for other purposes. For ordinary machinery for sawing, turning, planing, etc., there is not the positive necessity for steady motion which must exist in an electric light belt to secure satisfactory results. It is my desire to point out a few of these peculiarities and at the same time particularize some methods of prevention. Perfectly uniform motion, other things being equal, means steady, even, electrical force; and this, as I understand it, means uniform, steady light. One acknowledged advantage which pertains to the electric light, more especially the incandescence form, is its steadiness and freedom from flicker; and to obtain this a uniform belt must be used. This uniformity of belt must exist throughout its entire length, not only at the portion between laps, but in the laps themselves. The presence of anything which will increase the heft or thickness of the belt at the lap is no worse than at any other point, nor any less mischievous. No engineer would consider it an advantage to have the driving pulley out of true a quarter of an inch on one side, and yet this would have probably no worse effect upon the uniformity of the dynamo movement than an additional thickuess at the laps of the belt.

Another cause of irregular motion may be found in a slipping belt. A certain amount of suction (of the power known among engineers as vacuum pressure), which, of course means atmospheric pressure, is a positive necessity to hold the belt in place, and so make its pull uniformly. The more closely the belt hugs the driving pulley, of course the more perfectly and quietly does it accomplish the end sought. Now, it takes but little thought to comprehend, in fact, it is apparent on sight that a belt which is lifted from the pulley every four or five feet, allowing the air to enter the space between the belt and pulley, can only produce unsatisfactory results. Experience has demonstrated that the most perfect remedy for all this irregular action, from any of the causes mentioned, is in such a union of the laps as is produced by a scarfed joint, simply relying upon the cement, discarding rivets, pegs, wire or any other form of fastening. To accomplish these results, there is still one vital qualification necessary which I have not mentioned. Unless the belt has been properly stretched in the manufacture, the hard, rapid pull of the dynamo work will soon render it necessary to take out the slack. This should not be.

This proper form of belt is to be had, and the electric light fraternity of the West have quite generally indorsed its use.

Of the care of belting in use, a few words may not be out of place. The saturating of belting by any kind of oil is destructive. Belting stock, properly prepared, needs occasionally simply a slight coating on the grain. The dressings ordinarily offered in the market for this purpose are destructive. They are mostly of the mineral oil variety and contain more or less of those light products of distillation known as naphtha, benzine etc., and combine readily with many vegetable and animal products, and tend to destroy their integrity. There are belt dressings produced which not only do not injure, but really add to the life and power of the belt.

Without making invidious comparisons, I may, perhaps, be permitted to say that especial study has been made by a Chicago establishment of the needs of the electric light fraternity, and we who are intimate with the processes of manufacture are convinced that success must everywhere result from the use of evenly matched, uniformly thick belting.

Mr. GARRATT offered the following resolution:

Resolved, That the Committee on Insulation be instructed not to confine their labors to the question of insulating covering for wires, but to treat the question broadly, and that the next semi-annual convention embody in their report a thorough treatment of the problems involved in the setting of dynamos, converters, etc., and such allied information as may seem to them appropriate.

Adopted.

The PRESIDENT thought it would be well to change the title of that committee, and that it ought to be the proper insulation of wire and the proper installation and construction of plants.

It was agreed that that would be the title of the committee.

A resolution was adopted that a committee of three be appointed to revise and amend the by-laws, and report the same at the next meeting of the committee in August.

The Secretary then read the following paper by Mr. Wm. Baxter, Jr., on

ELECTRIC MOTORS.

The rapidity with which the electric motor has reached its present state of perfection is without a parallel in the history of mechanical devices by which energy is derived from the forces of nature. The fact that the energy of gravitation could be utilized through the agency of water from streams descending to a lower level, was known to mankind in days prehistoric and as far back as the days of Archimedes, water-wheels more or less perfect were used extensively for industrial purposes; yet, it was not until modern times, when the turbine wheels of the present day were invented that gravitation motors were brought to a state of perfection. Even to-day, with all the refinements of modern engineering, it is considered a very superior achievement that a turbine wheel, constructed on the most approved principle, will utilize 90 per cent. of the power in the current that passes through it.

The steam engine (which most people suppose was born in the fertile brain of Jas. Watt) was known and used by the ancient Greeks, although in a very crude form. They utilized the power of steam to impart motion to toys and other unimportant purposes. Through all the centuries that intervened up to about 300 years ago, improvements were unimportant; from that time onward, however, the energy of heat through the agency of steam began to be used extensively for industrial purposes. Steam pumping engines of large proportions were made and operated in various parts of England for draining mines; but as they were very imperfect and costly in operation, they did not displace animal power to any very great extent. Improvements were made, however, from time to time, until Watt, by a master stroke of his genius, made the improvements which gave to the steam engine a position in the industrial ranks and placed it far beyond the competition of animal power.

The steam engine, however, to-day looked upon by most people as a perfect piece of mechanism, is not and can never be as perfect as the electric motor. Not because our knowledge of the laws which govern the action of a steam engine is less than that of the laws which govern the action of an electric motor, but because there is a principle in nature, "the law of latent heat," which renders it impossible for a steam engine to utilize more than a small proportion of the energy of heat contained in steam or the vapor of any other liquid.

From what I have just said, it will be observed that the human race has been familiar with water-wheels for at least 4,000 years, and that the steam engine was known in its crude form over 200 years ago. The electric motor cannot be said to have been known, even in its crudest form, much earlier than 50 years ago; yet, in the short period of its existence, it has developed to such an extent that to-day it is as perfect as the best water-wheel, and far more perfect than a steam engine ever can be. Furthermore, the laws of electrical science, in so far so they relate to the action of an electric motor, are so thoroughly understood that it is possible to obtain as perfect results to day as is within the limits of possibility. And should the human race inhabit this globe to the end of time, it will never be possible to make a much more perfect motor than can be made to-day.

This statement may appear broad, but I venture to make it, and will explain why it is made. To those familiar with the laws of physics, there is no such thing as creating energy. All that can be done is to convert one form of energy into another. A given amount of energy in one form can never be made to give more than an equivalent amount of energy in any other form. To illustrate my meaning more clearly, I will say: An amount of heat energy the equivalent to one horse-power cannot possibly be made to develop more than one horse-power of mechanical energy or work, even with a theoretically perfect steam engine. And one horse-power of electrical energy cannot be made to give more than one horse-power of work, even with a theoretically perfect motor. It is no more possible to create energy than to create matter. You may take a pound of putty and form it into any shape you please, but it is still one pound. You may roll it into a ball or draw it out into a string, it is the pound of putty still. So it is with energy. You may transform it from heat into electricity, from electricity into molecular or mass motion, and from motion back into heat, but you neither decrease or increase it. There are men, however, who do not understand this fact, and believe that there is no limit to the power that can be obtained from a given electric current, and that, therefore, some one may at some future time discover some way by which 100 horse-power or more may be developed from the same amount of current that is now used to develop one horse-power. Any such result is beyond the limits of possibility or reason.

To-day we develop nine horse-power from an electrical energy of ten-horse power; one-tenth of the whole is all that is lost. Therefore, all that the future workers in the field can do, is to recover a part of this one-tenth. They cannot recover all, because there must necessarily be some loss.

Therefore, I believe I am within bounds in stating that

it will never be possible to make a much more perfect motor than is made to-day.

A theoretically perfect motor would be one that converted all the electric energy passing through it into mechanical energy available outside of the machine. Practically such a result is impossible, for the reason that no mechanism can be made to run without friction, and no electric conductor—no matter how large—can be made without resistance; therefore, there must necessarily be a loss in friction and electrical resistance. This loss can be reduced a great deal, even beyond the point to which it is reduced in the perfect and practical motors of to-day. The only thing to limit the point to which these losses can be reduced, is the question of expense in construction. A motor can be made to convert $\frac{9}{10}$ of the energy of the electrical current into power without going to any unreasonable expense; but it is doubtful whether the increased cost of construction necessary to attain a higher result would be compensated for by the additional gain in efficiency.

Now, it may be asked whether the electric motor—inasmuch as it is as perfect as man can make it—has reached a point where it is susceptible of every application which can be made of it at any time. To this, I would answer that it has not; that the applicability of the motor depends upon the cost of generating the current with which it is driven. The cheapest way in which an electric current can be generated at the present day is by the use of large dynamo machines driven by large steam engines of the most approved construction; and inasmuch as the best dynamos must lose something in converting the power of the steam engine into electric energy, and the motor also lose something in converting the electric energy of the current into dynamic energy, the power obtained by the motor must necessarily cost more than that developed by the original engine which generates the current.

Nevertheless, as large steam engines are much more economical in their action than small ones, and the cost of attendance is less in proportion to their size, it is possible to utilize the current generated by them to develop power in small quantities, at a cost low enough to compete with small engines. Up to just what point the cost of power so developed will be cheaper than steam cannot be stated with any degree of accuracy, because it depends upon a great many circumstances. In one locality, a motor up to 25 or 30, or perhaps 40 h. p., may be able to compete with a steam engine, whereas in some other locality under other conditions, a 50 h. p. motor may barely be able to do it.

If we were to take into consideration the absolute cost of generating power only, then electric motors of a great deal higher power would be able to compete with steam engines. But the electric current will be generated by electric light companies who conduct their business for a profit, and therefore the price which the user of the motors will have to pay for the electric energy he consumes will not be the net cost of developing that energy, but will be that net cost, increased by the profit which the electric light company desires to make. But, notwithstanding this increased cost occasioned by the desire of the electric light companies to make a profit, electric motors can compete successfully with steam in point of economy, and when convenience is considered, can compete not only with steam, but with any other method now employed for obtaining power in small quantities.

In all large cities and towns, people using steam engines rent surplus power to manufacturers in the same building or near by. In a great many cities there are establishments whose business is to run large engines for the purpose of letting out their power in small lots, the price of which is generally low enough to compete with small steam engines, and therefore these prices, as well as the amount of power let in individual cases, can be taken as a guide by electric lighting companies desiring to do business in the same district. If these concerns can make money at the prices fixed, electric lighting companies can make more, for the reason that the loss in transmitting power through shafting and belts is greater than the loss in transmitting it through electric motors.

In determining the cost of power, to consider simply the amount which is paid for it is not the only consideration, as many other expenses enter into the question. For instance, the rate of insurance on a building in which the work is of a hazardous nature will be very materially affected by the introduction of a steam boiler. This increase in the rate of insurance must be added to the cost of running a steam engine in comparing it with the cost of a motor to do the same work.

Again, in populous cities, and in busy portions thereof, space is of great value, and the difference in the amount of space which may be used by different kinds of motors employed should also be taken into consideration. Then, again, where a manufactory is located on the upper floors of buildings, and the lower part is used for offices or stores, the jar, as well as the noise occasioned by the steam engine, would be such as to make the tenants object to its introduction; and on this account the proprietor of the building would demand a very much greater rent, so that, if this rent were added to the cost of the steam engine, it would be found that it would more than make up the difference between the actual or apparent cost and the cost of running the electric motor.

Besides the actual expense in dollars and cents, the question of convenience ought to be considered; because sometimes, although there may be no means of determining just what difference convenience may make, financially, it is nevertheless apparent to all, that it is worth while incurring additional expense, provided a proportionate increase in convenience is obtained.

The superiority of an electric motor over the steam engine in point of convenience is: First, that it takes up very much less room, makes much less noise, and is a very clean and simple machine which does not require a skilled mechanic to keep it in order. It does not have any stuffing boxes that have to be packed from time to time, which are liable to blow out at any time and fill the place with steam; neither does it have any steam pipes, which are likely to burst or spring a leak when least expected. There is no annoyance occasioned by carrying coal or removing ashes, neither is there the liability of injuring the work by soiling it, if the location of the building is such that it is necessary to carry the ashes or coal through a portion of the working rooms in or out of the building.

When we come to compare the conveniences of the electric motor with those of other hired power, we find that it possesses equally great advantages. If a man decides to hire power he must go into some section of the city where power can be obtained. He must content himself with rooms such as he can find, and it frequently happens these rooms are let out to any tenants that may come along, or may be in bad condition or cut up in such a way that it will require a considerable outlay to put them in a condition adapted to the business. On the other hand, if he buys a motor, he can select a building in any portion of the city that may suit him, and, after finding a building entirely to his liking, can locate the motor therein in any position in which it will be the most convenient, and simply notify the electric light company to introduce the wires.

It may occur to some that this is not strictly true, because he may select a building in a location far removed from the electric light mains; but this is altogether unlikely, for the reason that electric light companies run their wires through very nearly all the manufacturing districts of the towns in which they are located, and even if they did not have a wire running through the street in which he might locate himself, they would certainly run so close that they would be perfectly willing to extend their line to his place for the sake of the revenue to be derived from supplying his motor with current.

There is another way in which electric motors can be used, and in which they will be able to compete with steam engines of almost any size, and that is where the power of water-falls can be utilized to drive the dynamos that generate the current. There are many places throughout the world where vast water-powers within 20 or 30 miles of large business centres are going to waste, where such plants could be established and made very profitable. The distance to which currents generated in this way could be carried profitably would depend very largely upon the extent of the water-power. If the supply be unlimited, the company could afford to lose even half the electric energy in transmitting the current to remote places, and still furnish it at such price as to monopolize the business of furnishing power. Therefore it may be said that the distance to which power could be transmitted in this way would range, say, from 10 to 100 miles, or even more.

In the foregoing remarks I have endeavored to show the various ways in which electric motors may be employed at the present time. I have tried to point out the particular uses in which they will be found more economical, convenient, simple, durable and reliable than any other means heretofore used.

In summing up the case I would simply add that the office of the electric motor at the present time is simply to develop power in small quantities and that it may also be used as a means of utilizing the power of water-falls that may be within a reasonable distance of large manufacturing centres.

The field which the electric motor can fill at the present day is limited to the cases cited, because we have no means of generating electricity cheap enough to extend the sphere of its usefulness. The most economical way of generating an electric current at the present day is by the use of dynamo-electric machines, but inasmuch as these machines are driven by steam engines, and there is a loss in generating the current as well as a loss in reconverting it into power, it is simply impossible to generate the energy in the electric motor as economically as in the engine. If we were to use any of the electric batteries now known, the results would not be so good, for the reason that the cost of obtaining the current in this way is yet greater. There are batteries made which are decided improvements in point of economy over the batteries of former years, but they all generate the current by chemical decomposition of zinc, and so long as such means are used, the current generated can never be cheap enough to compete with a current generated by a dynamo machine, much less to enable a motor to develop power cheaper than a steam engine.

When a battery is invented in which the material consumed by chemical action is sufficiently cheap (say, for example, coal), motors run by the electric energy developed in such batteries will surpass steam engines in point of economy; but until then, they never can.

The cost of generating an electric current in a battery can be ascertained with extreme accuracy when the nature and cost of the material used is known. This is owing to the fact that in every case the current is generated by chemical action which takes place in the battery, and this chemical action, which is simply a form of motion, can only be made to develop an amount of electric energy which is proportional to it. A pound of zinc decomposed in a cell of an electric battery will develop a certain fixed amount of electric energy, regardless of the nature or construction of the battery or of the liquid used in it. Whether the amount of electric energy available from such a battery is more or less than that available from any other battery in which zinc is employed, will depend upon the perfection of its construction. But, assuming it to be theoretically perfect, the amount will never exceed that which would be the true dynamic equivalent of the energy due to the electrical action necessary to decompose the zinc. A pound of zinc will not develop as much energy as a pound of coal, and inasmuch as a pound of coal costs a great deal less than a pound of zinc, it will be seen that if a battery could be made to use coal instead of zinc, the cost of generating the current would be so much cheaper as to admit of no comparison. To make such a battery is not an impossibility. It may not be made for years to come, and yet it may be brought to the light of day when we least expect; but whenever it is made, or whenever a battery is made in which any other substance sufficiently cheap is subjected to chemical action, then the electric motor operated by the current of such batteries will develop power at a much lower cost than it is possible to do it with a steam engine, and it will therefore take its place and be the power of the future, while the steam engine will occupy a prominent position in the curio halls of science, and will be pointed out to the children of future generations as one of the crude devices used by their benighted ancestors in days gone by.

DISCUSSION.

Prof. EDGERTON: In the paper we have just heard read, there is a suggestion which it seems to me should occupy the attention of the convention, and that is, in regard to the cost of supplying the electric current for motor purposes. What is wanted by our electricians and those who dispense and sell the current is to know whether there is going to be a large demand. If there is going to be a demand, and if it is to be permanent, I do not think there is one of you but will at once prepare for the work. Now, judging from the correspondence we have, and if we look over the field, I do not believe any man can shut his eyes to the fact that where one customer will use electric light, ten men—yes, a hundred men—will use electric power. The motor has also this advantage as to permanency. The electric light is to all intents and purposes a luxury. Your business man, as soon as trade falls off, says, "Take my lights out, I am done with them for the present; I can get along with gas for the time being." If he can't get gas, he can get something else. But when you take a motor and put it into a man's place and put money in his pocket, and give him something which is better for him, you have got that man's business as long as it continues. For that reason, I think, the electric light companies have the prospect of a large new business with a royal percentage of profit coming in. I want to suggest that this convention appoint a committee to take in hand the matter of the price of furnishing current by the electric light people, and to prepare a list or scale of prices that would be mutually satisfactory, the committee to offer it at our next meeting.

Mr. DECAMP thought the suggestion a good one, and stated that the price they were getting for motor service in Philadelphia was 65 per cent. of that for electric light. They had no definite data to go on, but were charging at the rate of $5 per month for 4 small sewing machine motors.

Mr. DUNCAN said he had had some little experience in the distribution of power with motors. They were running in Pittsburgh altogether sixteen motors varying in size from a half to ten horse-power. These motors were all running with one exception upon the direct incandescent current. The question as to the relative cost of light service and power service was not sufficiently advanced for definite and equitable settlement. He had no hesitation in stating for the information of the Association that he could obtain from the distribution of power twice as much as he could for light. They had no difficulty in placing these motors at all. The demand came to them, they did not go after it. Furthermore, the satisfaction obtained was such that they had on record in their office statements to this effect: parties who have used these motors for six months, as against steam or gas power, would be willing to pay 25 per cent. more for the electric service. Of course, that was gratuitous on their part, for he should certainly ask them next year to step up instead of down.

As regarded the maintenance of motors and the amount of service required to keep them in order he would say that as far as he could see, and as compared with an arc system, the motor requires no particular attention at all. An arc light did require particular attention, and from his experience he would say that the carbon trimmer, after a little training of a week with a motor in the shop, could, if he were at all a competent man, make a round to all the motors in service and keep them running. In Pittsburgh they simply made a round twice a week to every motor in service. The man made a report. It formed part of his duties, the same as his carbon setting and the report on his lamps. He could not see why, where a light station was properly equipped for doing business, there should be any increase of force or attendance necessary, whatever, for the distribution of power, say up to 100 motors in service. That was, where the district was already covered by the light wires. Outside of that, it was a matter of development, the same as anything else. "I think we have arrived at that point where we can safely say that in large cities the distribution of power by means of electricity is one that will pay to run either as a separate plant or in connection with the lighting business. It is simply a question whether the lighting people are going to keep that business to themselves, or whether they are going to allow somebody else to step in and take it as a separate business. In regard to the amount of investment and the relative cost, I would simply say that after we had placed four or five motors we arrived at the conclusion that it would be a very good thing for the customer to buy the motor—in other words, it would be a very good thing to have the customer interested in the business. I may say that so far the majority of our motors are owned by the subscribers, and that one person in the employ of each concern gives an eye to the motor. We make the inspection, and see that they do not crowd on more work than we guarantee when we make the bargain."

Mr. MORRISON said that they were all aware that in large cities the efforts of the local authorities had been in the direction of encouraging small industries, by taking off taxes, giving them free water, and so on. From one end of the land to the other the effort was being made thus to stimulate small manufactures. But one of the principal drawbacks was the impossibility of having steam power so arranged as to be distributed in localities where rentals were cheap, and where there were facilities for men with small capital—shoe-makers, tailors, small machine-shops, box-makers. A thousand and one such industries can be carried on, and would be carried on, with profit, and with benefit to the community, if it were possible to furnish the power to run the machinery for the work. Furnishing a steam plant and renting out steam power was attended with many difficulties, beginning first with the placing of the boilers, which were very often objectionable to owners of property adjoining. One way of meeting the difficulty had been found in concentrating a number of trades in one building owned by the man who controlled the steam plant. The rentals were therefore under his control, and he fixed them so as to make his investment a paying one. But it was not a paying matter for the man who wanted to run a small shop on the fourth or fifth floor, and he was practically shut out from the prosecution of his trade for himself. Hence the aim of such municipal legislation was virtually defeated at the outset. You could not distribute steam power efficiently and cheaply over a large district. That question was settled. But now let them take the electric light companies who already had their wires stretched all over the various cities of the Union. Recent statistics had shown to what extent the arc and incandescent light was being used, and how there was thus, almost at the door of every man, the facility for using electricity as a motive power for whatever small industry he might be engaged in. That being the case, and looking at it from the other side, it had been said that if they had 1,000 horse-power they could sell 2,000 horse-power on a varied service and have absolute security. At any rate, he believed they could use a very large proportion above the actual capacity, where they had to utilize power intermittently, and to such an extent as to much more than compensate for the difference mentioned before between lamp and motor prices. He did not know any lighting company whose contracts, outside of municipal would average more than 60 days in the year—except in Philadelphia.

Taking the average, they would say 90 days. The balance of the time they had three-fourths of their plant idle. They had to equip to supply a maximum demand. Now, then, if they made a contract for power, they made it from one year's end to the other. That was the case so for as concerned Baltimore. That was the promise given there, that they made their contracts by the year and the rate of charges was governed by the rate of charge for steam per horse-power. It did not require the gift of prophecy to foretell what would be the result of that sort of business. For three or four years they had been waiting for the motor to come along. If the proper motor had now been presented to the public, that part of the question was settled, and in the next twelve months or two years they would find a very remarkable addition to their service and a very pleasant addition to their profits if they chose to introduce the motor. It was a question as to whether to do this was good policy for an electric light company. There were always troubles with divided responsibility. He was not himself quite determined on that point. It might perhaps result in the formation of a motor company to do the motor business, making a contract with the electric light company for its current. That would make those operating the motors responsible for the motor service, and at the same time relieve the electric light company of additional expenses. On the other hand, the motor company would be relieved of power plant expense. That was the way the idea suggested itself to him, and all these points must be considered. He did not think that any of them had gone sufficiently into the question to settle it just yet one way or the other, as to whether or not the motor business was desirable simply as an adjunct to the lighting business. He did not believe it could be solved in any way except by practical work. The nearest thing to practical work was the report of Mr. Duncan, who stood in his place and told them the result had been a profit to his company. Mr. Duncan was a living witness to the profit and benefit of the motor business for an electric light company. Altogether, from the present outlook, he believed that the report of investigators in that field would be in favor of motors as a proper and profitable method of power distribution.

Mr. UPTON reminded the convention that 18 months before he had, in New York, urged on them that very point. In Boston, the motor subject had been satisfactorily taken up and dealt with. The Edison station there had 800 horse-power, and one-third was now used in transmitting power electrically. It had proved a valuable addition to the economy of that station, much larger than they could possibly conceive. He believed that all central lighting stations should put in motors. The additional cost was small; in some cases running all the time it was simply the cost of the coal used, with possibly the wages of a few inspectors. In fact, the whole question had been satisfactorily settled in Boston, where they were running elevators two miles from the station, both passenger and freight, with most perfect success.

Mr. HARDING stated that in Boston they were getting $125 per horse-power per year for a day of 10 hours. They preferred the contract system as the only sensible one to use with the supply of intermittent power. Another point he would insist on strongly was, to sell the motors and not to rent them. They had sold every motor they had put out in the city of Boston. As a result, the customer took excellent care of the motor. When the motor was placed in a shop, a good reliable man was selected to take charge of it there, fill the oil cups, start it in the morning, etc, Then they had an inspector who went round at certain intervals to see that everything was all right. Another point was, not to have the motor overloaded. In Boston with about 40 or 50 motors they were deriving an income which was paying the local Edison company on its total original capital of $100,000, eight per cent. from power alone. Every day men were coming to the motor company wanting to buy motors. The motors were now called for in very much larger sizes, at present more 10 h. p. than any others, but 15 and 20 were in demand. These motors had a guaranteed efficiency of 90 per cent., and the horse-power was guaranteed. In one case, where a motor had been overlooked, it ran for 7 weeks without inspection or attention, but he advised systematic inspection, which would only take one minute in each case. As regarded elevators, there was certainly nothing in machinery, say, up to 20 horse-power, that the motor would not do. They were now running the largest elevator in Boston, a freight elevator 12 feet long, 6 feet across, going 60 feet a minute. They were also running a passenger elevator going 100 feet a minute, and both were run from the same motor of about 15 horse-power. He thought it desirable to have data collected as to power required, etc. As to fuel, in Boston they were burning cheap fuel, three tons of screening, costing about $2, and one ton of Cumberland, mixed, costing altogether delivered, about $2.50 a ton. They used the Jarvis setting, and from that got excellent results. A large proportion of the business was elevator work in the wholesale part of the city. About half-past 4 it was almost entirely deserted, and so the power business began to go off as the lighting came on. It would be different in different cities. They were not using one-quarter of the current they could obtain from the station. The circuit upon which motors were running in the day ran lights also.

Mr. MORRISON: That is the secret. Nearly every station is now running a day circuit which is not loaded to its full capacity.

Mr. KERR held that only when the incandescent wires embraced the residence portion of a city would they be able to sell much beyond their actual capacity. For instance, in one town where the total call for incandescents would be 7,000 lights, the business portion took only 400 lights. Now, when they got the 7,000 lights, including the big residential area, they could rent power or light far above the station capacity. Companies that went out into residence districts found that they did not have to increase their stations so rapidly as their rented capacity would indicate. He knew stations in this way running 1,300, 1,400 and 1,500 lights from two 500 light machines, because there, if a man went to the church, theatre or hall, he didn't burn his light at home, and if all the lights were going in one house, it was because a party was going on there while all the lights in the neighboring houses were turned off, the people being at the party.

Mr. DUNCAN and Mr. KERR agreed that as for instance in Pittsburgh, 33 per cent. might be figured on as the excess margin that could be contracted for.

Mr. GARRATT took exception to Mr. Baxter's point as to the greater cost of zinc as a fuel than coal. A good engine would not show at the pulley more than 13 per cent. of the energy in the coal burned under the boiler, so that the difference was not so great as might appear. While no man in his senses would claim that zinc was a cheaper fuel than coal to burn, there were occasions when zinc had a special use and place. He instanced a case in Boston where he furnished a motor with battery for a store. He had charged the parties a good rate for it, but they sent back, wanted to know the price for the whole, and bought it outright. Evidently there was a use for zinc as fuel.

Mr. R. T. MCDONALD: One thing I want to call attention to in connection with motors. We are all in the electric lighting business to make money, and the tendency in lighting has been to get prices too low. I understand it is proposed to appoint a committee to fix prices which are to be charged for motor service, and in that connection something has been said in regard to the proportion of motor rates to light rates. My experience is that the price of lights varies very considerably all over the country. In some places these rates are fair, in others ruinously low. Now the motor price ought not to be considered in that way. The price to be charged for motors ought to be on the basis of the cost of coal, instead of the rates charged for light. I think it is a growing business, and it will not be long before the majority of the electric light companies will be using motors. It is highly important therefore for them to start out on a basis that will pay them. It is easy to go down on price, and hard to to get up.

Mr. DECAMP stated that they rented one man five motors and charged him, as usual, $6 for them. They rented another man ten motors and charged him $11. The man with the ten motors gave up business or moved, and sold them to the man with five. That man threw them all in together and thus ran them a couple of months, paying $6 for the service of the fifteen. That was perhaps to be met by cutting out automatically when any excess was thus taken.

Mr. R. W. POPE: That difficulty was obviated by the Gold and Stock Telegraph Company, in New York, originally by charging the subscriber $100 for installing the instrument. It was understood in the lease that this did not give him the ownership of the machine. He had the privilege of having the machine, but if he gave up business, he could not take the machine with him. The company retained the machine, also the hundred dollars. The original subscriber retained his privilege of leasing the machine. If he could find another party desirous of taking the machine, he could make a "dicker" with him. It was practical ownership, but the company thus controlled the property at all times.

It was decided to consider the motor rate proposition at the afternoon session.

Mr. WEISSLEDER read the following interesting letter:

BRUSH ELECTRIC LIGHT CO.,
DETROIT, Mich., Feb. 3, 1887.

Brush Electric Company, Cleveland, Ohio:

GENTLEMEN: I thought it would be of interest to you to hear a report from your No. 4 six horse-power motor recently erected by us.

We put it into Raynor's printing establishment in this city, and connected it with our regular arc light circuit. It takes the place of a 10 h. p. engine, which was formerly employed, and which sometimes stalled under its load. It runs about seventy to eighty feet of shafting; it drives right along on the first floor three cylinder presses, four platen presses, one large steam paper cutter and one very heavy freight elevator. Power is then transmitted by a 4 inch belt up through three floors and there drives three ruling machines and four paper cutters.

It does its work splendidly, and its motion is steady and regular. The proprietor informed me this morning, after some ten days' use, that it worked splendidly, and that printing offices and others could well afford to employ it instead of steam, even though it might cost more.

We are having very many inquries for these motors just now, and I find that Mr. Raynor takes pleasure in extolling the merits of his motor to all visitors and inquirers.

Yours very truly, WELLS W. LEGGETT, President.

WEDNESDAY AFTERNOON SESSION.

Mr. HENRY HINE offered the following resolution.

Resolved, First—That the report of the Legal Committee be referred to a committee of five, to be called "the Committee on Patent Legislation."

Second—That it shall be the duty of this committee to carefully consider the report and proposed bill, formulate a plan for the presentation of this matter to Congress, and report at the next session of this Association. Adopted.

Mr. A. F. UPTON read a paper on "Plans for Installing Central Stations." He showed also plans of the Boston Edison station. THE ELECTRICAL WORLD also presented a large 8-page folder, giving views of about a dozen stations in America and Europe, showing great difference in system of construction and equipment. Mr. Upton's paper is as follows:

STEAM PLANTS FOR ELECTRIC LIGHTING.

It is not intended in this paper to consider the subject of electricity or of electric lighting, except in such manner as pertains to the erection, equipping and running of central stations, either for arc or incandescent lighting, transmission of power or for street railways, and to the economical production of power for these purposes I wish to call your special attention.

When we take a retrospective view of electric lighting, and consider the advancement made since 1879, it is astonishing to recall the fact that at that time there was not in existence in the whole world a central station for electric lighting. In 1878 the Brush Company made experimental tests at the Mechanics Fair in Boston, and in 1880 they started their first central station in New York, which was followed by others in Albany, Baltimore, Cleveland, Boston, etc. To-day there is scarcely a city or town of 20,000 inhabitants in the entire country which has not a central station either for arc or incandescent lighting, and in many instances towns with a population of from 3,000 to 4,000 are supporting an electric lighting business.

In starting a central station, the first matter to decide upon is a proper location, and this requires the consideration of a number of important questions, among which are convenience for coal and water supply and a location central to the lighting area.

The site having been determined upon, the next question to be considered is the character of the building; brick would of course be preferable for both the boiler-house and machinery building, but ordinarily the engine and dynamo rooms are constructed of wood and the boiler-house of brick. In either case allowance should be made for increase of plant in the primary structures and also sufficient land for increase of station buildings; for the inevitable necessity of this electric lighting business is to increase the plant, and the great mistake made by the pioneers of the industry has been in not allowing for this increase.

Size of buildings must be governed to a certain extent by the size of the city or town in which the station is to be located, but for an ordinary plant we find the following dimensions well adapted for the purpose; and our company has recently erected a station of these dimensions which is spoken of as a model plant.

The main building is of wood, two stories in height, with brick wall next to boiler house, and is 80 feet long by 36 feet wide; the dynamo and engine room is 16 feet in height in the clear, and the upper story (14 ft. in the clear) is arranged to let power for manufacturing purposes if desired.

The boiler-house is of brick, 40 feet by 40 feet, and 20 feet in height, allowing of nearly 10 feet between the boilers and roof, and in addition there is a large ventilator in the roof.

This plant starts with one tubular boiler, 6 feet by 16 feet, with ample room for two more of same size, and with proper passages at sides and rear of the boilers, and a 16-foot firing space in front, well paved with brick.

For a chimney they use an iron stack 70 feet in height, 42 inches in diameter at the base and enlarging to 48 inches at the top; this stack being of size sufficient for another boiler.

They have one high-speed engine belting direct to the dynamos (one belt from each pulley of the engine), and with room for five more, which will be put in as needed.

This plant is arranged for both arc and incandescent lighting, also to furnish power for an electric railway, and, when fully equipped, will easily develop 400 h. p. There is also land sufficient to duplicate this plant.

Starting on the basis that the manufacture or production of electric lights was, in reality, merely selling power, we made it our aim to so equip these electric lighting stations to use such apparatus and fuel as would obtain the greatest amount of steam at the least possible cost, and to avoid as far as possible all loss between the boilers and dynamos.

The tubular boiler seems to be the standard among the electric stations, though many of the sectional boilers, especially the modern ones, have advantages well worthy of consideration.

On the basis of tubular boilers, we say without reserve, put in steel every time; don't be satisfied with homogeneous steel which can cover anything known as steel, but have specifications on flange or, better, still, of fire-box steel of some good brand. For the heads use flange steel. Don't put in a small boiler; a good 6 ft. tubular costs but little more, takes up but a little more room and the setting is but slightly more expensive than a 5 ft., while the capacity is almost double.

In putting in the foundations of the boiler setting, put them in for two boilers; they will be needed later, and such work is inconvenient when running a station.

We say, as a matter of course, set the boilers on the Jarvis furnace and use the cheapest fuels you can buy. Let the projectors of any electric business take the trouble to investigate in their locality and see what cheap fuel can be procured; it is generally safe to say that they will find either slack coal, screenings, sawdust, wet tan, coke-screenings or similar refuse fuel, and every such opportunity should be taken advantage of. The question in selling electric lights is not how many pounds of coal per h. p., but rather what is your cost per light. How many pounds of water can you evaporate from your boilers for one dollar's worth of fuel?

On the point of economy among the Edison stations, where Mr. J. H. Vail, their general superintendent, has perfected a system of records from all their stations, by which accurate comparisons may be made, it is worthy of note that the highest stations on the list have their boilers set on the Jarvis furnace and, using cheap fuels, the same result is being shown among the Thomson-Houston companies where a similar plan is being adopted.

In setting the first boiler, build one outside wall as the middle wall for a second boiler; it is also wisdom to put in an iron stack (if iron is used) large enough for two boilers, and the first cost of a pump, heater and injector large enough for two boilers is but little more than for one. For feeding the boilers we advise using both a pump and injector, using the pump in connection with a heater when the engine is running, and having the injector as a reserve feed, also to use to furnish the boiler with hot water in case the engine is not running. For boiler fittings we consider that a nickel seat pop safety valve is none too good, and it is very poor economy to attempt to save a few dollars at the expense of safety. A cheap set of grate-bars is sure to prove the dearest in the end of anything about the entire plant; it costs more at first to put in a set of first-class rocking grates, or of stationary grates, but continuous running expenses are to be considered fully as much as first cost, and, to judge the future by the past, those companies which do not have their plants equipped in a manner to produce low-cost power will be obliged either to remodel their plants or be forced to the wall by the active competition which is springing up among the different systems.

To consider briefly the question of engines, I will state that we were the first to adopt what has since become almost the standard for successful electric lighting stations—the system of using small high speed engines belting direct to the dynamos. We had experience first with the long-stroke engines, and were very soon satisfied, from the many objections arising, that some different plan must be substituted. In the first place, the friction of the large engines, necessitating the use of shafting, together with loss due to the extra belting, is nearly double what is shown to be the practice in running the small engines. Again, if it is desired to run a small number of lights, it is a waste of power to run an engine greatly out of proportion to the work. It is the case in many stations where the commercial lights are on a different circuit from the street lighting, that they are obliged to start and run a large engine from one-half to three-quarters of an hour just for a few commercial lights, while, by the use of a small engine, the load could be adapted for the store lights and the main lighting put on as required, and when time to cut out the store lighting, it is only necessary to shut down the engine running that circuit, and stop all expense pertaining to it.

If an engine gives out, the whole of the lighting is not stopped, as would be the case in the use of one large engine; and, in a station using a number of small engines, one reserve engine is practically a duplication of the en-

gine power. Referring to the economy of these small engines, I will read an extract from a report of a recent test made by Prof. Thurston at the station of the Narragansett Electric Lighting Co., at Providence, using A. & S. engines of 50 h. p. each and lamps of 2,000 candle-power. He reports as follows:

"When the engine was running without load, the steam consumption was 26.2 pounds per hour and per horse-power; when driving the dynamo alone, 25.6; when 25 lights were on, 21.3; when 50 lights were on the consumption was, according to the cards, 21.5 pounds. The economy of driving direct to the dynamo without intervention of countershafts is well shown by these trials. The expenditure of power was, in this case, but seven-tenths of a horse-power per light when fully loaded, while the power demanded when a countershaft is used is often reported to be 25 or 30 per cent. higher. With 60 lights in the circuit the power expended was, in this case, just 0.7 horse-power per light." The Armington & Sims engines, of which we act as selling agents, are made of both types; double disc engines with two wheels, arranged to belt direct to dynamos, and also single disc, with which it is necessary to use shafting; and the results of our extended experience have been such that I do not hesitate to say that we do not consider that a station with shafting can compete with any degree of success with one equipped to belt direct. In piping from the boilers to the engines, we place valves so that either boiler or engine may be shut down without interfering with the running of the balance of the plant; and in piping the primary portion of the plant we put in the main steam and exhaust as near what the ultimate capacity of the station would require as can be determined. We also provide a muffling tank for the exhaust where there is any question of the noise of the exhaust being the cause of trouble.

COMBUSTION.

The subject of combustion of fuel is of sufficient importance among the electric light people to merit a few general remarks on the matter, and it is a subject that is far less understood by steam users than any one would suppose, considering the cost of the fuel consumed in making the steam in this country, and the following facts should interest all parties using steam power:

1st. That coal is distilled into gas before it can be properly burned.

2d. That to burn this gas, a sufficient supply of hot air must be introduced at a temperature not low enough to cool the gases below their igniting point.

3d. Every time a lot of fresh coal is thrown on the fire a great production of gas occurs, and if it is to burn to a flame it must have a corresponding supply of hot air. After a time, when the mass of fuel has become red hot, the supply of gas is greatly diminished, but at first the evolution of gas actually checks the draught; but bear in mind that, although no smoke may be visible from the fire, it by no means follows that its combustion is perfect; if you diminish the supply of hot air, or reduce the air-space of your grate-bars, you will be merely distilling carbonic oxide gas up the chimney.

4th. In ordinary boiler furnaces there is an insufficient supply of air; fresh coal is put on the grates and the firing doors are closed; gas is being distilled from this coal. Now, if you do not furnish air above the fire (and it must be hot enough to ignite the gas), how can you expect to get combustion? Whether it is expected or not it does not burn properly, and your boiler furnace is nothing more than as a gas retort in a gas works, making crude gas and wasting it up the chimney; in other words, a first class soot and smoke factory.

Therein we claim the principle of the Jarvis furnace to be correct; it does furnish pre-heated air to ignite and consume these gases, and make flame and heat otherwise wasted in the chimney; and further, it allows of the use of fuel or a class of fuels that, in an ordinary furnace, will produce little else than soot and smoke.

SMOKE BURNING.

As most boiler furnaces are constructed they are nothing else but gas producers, that is, all gas producers are extra bad stoves or boiler furnaces. Consider how ordinary gas is made: there is a red hot retort or cylinder, into which you shovel a quantity of coal, which flames and smokes vigorously as long as the door is open; when it is full of coal you shut the door, cutting off the supply of air and extinguishing the flame. Gas is now simply distilled and passes along pipes to be purified and stored. You perceive at once that the difference between a gas retort and an ordinary boiler furnace with closed doors and half-choked grate-bars is not very great.

Consumption of smoke, using bituminous coal: It is not a so-called "smoke burner" you really want, it is a fuel consumer. You distill your fuel instead of burning it in nine-tenths of your boiler furnaces. There is no such thing as "burning smoke." Once made, it cannot be burnt, and the only way I know of burning it is not to make it.

AIR FEED.

The question of supplying hot air, and the amount to be supplied at the right time, is a question that has puzzled the most scientific men who have made a study of this most important question. The Jarvis furnace is so constructed that the damper regulates the amount of air delivered into the boiler; if the full force of the draught of the chimney is required then the open damper allows a full supply; a half damper gives one half the supply, and if the damper is closed no air enters the furnace over the fire. Every first-class steam plant should use a steam damper, and with such a damper the feed of hot air is perfectly automatic. The Jarvis furnace for setting steam boilers is constructed in the following manner:

It is the same principle as the Siemens-Martin furnace for making steel. In a different manner, and on a smaller scale, we pre-heat air (oxygen) and discharge it over and back of the fires, thus utilizing and igniting gases generally wasted. The joining of hot air with gases creates a draft and allows the combustion of low grade fuels that would otherwise require a draft to burn. Smoke is reduced to a minimum by this process. If the fuel is wet it is an advantage where hot air is used.

The principal thing to my mind in regard to electric lighting is the cost of power. I have always claimed from our experience that the matter of power in this regard was figured in one sense on a wrong basis. My idea is, to get at the bottom of all economy in electric lighting, the cost of power should be most carefully looked at. The only thing to be considered is the actual cost per lamp per hour, not evaporation of pounds of coal per hour. It is the actual cost of running an incandescent or arc lamp per hour.

The only money to be made in the future in electric lighting under the coming competition is to be made in saving. Reduce the cost of fuel, use only the cheapest and lowest cost grades. Why use the highest cost coal when slack coal, screenings or pea coal can be purchased at one half price, and with proper furnaces evaporate the same amount of water as the highest grades of coal?

Such in general is my idea of what would be the best and most economical for an electric lighting station, and which is well shown in the blue prints. Should any member desire one of the prints, we will be pleased to furnish it. We have equipped some stations under conditions which required a great deal of ingenuity to accomodate a given power in limited room, of which the Edison Central Station of Boston is a striking case of what can be done. I have a full set of blue prints of that station, and it may interest some of the members to listen to a general description of what has been done there.

I will say respecting this station and these plans, that although we did the work of fitting out the station, the design work and plans were made by, and done under, the supervision of the engineering department of the Edison Co., and I am indebted to Mr. J. H. Vail, Gen. Supt. of that company, for his courtesy in furnishing the prints and allowing me to exhibit them.

The following resolution was next presented by Mr. De Camp:

Resolved, That the chair appoint a committee of five having experience in operating motors from central stations to tabulate rates for motor service, their report to be upon the basis of the price received for arc and incandescent light service, and that the report be received and considered by the next meeting of the Association.

Mr. DUNCAN: I would suggest that it would be well to confine it to stations operating not less than 300 horse-power. I offer that as an amendment.

The amendment was accepted and the resolution adopted.

The PRESIDENT appointed as a committee on the report of the chairman of the law department Mr. Arthur Steuart, Mr. Kerr, Mr. Ridlon, Mr. Sprague, and Mr. Morrison.

The President introduced Mr. F. J. Sprague, of New York, who spoke as follows on the subject of

ELECTRIC MOTORS.

I feel that I owe you an apology, as I see that it is stated on the programme that I am to read a paper on the transmission of power. The duties, however, which have devolved upon me during the past two or three weeks have been of such a character and demanded so much of my time that it has been simply impossible for me to write a word on the subject in question. What I have to say will therefore be entirely extemporaneous; and if there is a lack of logical sequence in my statements, or I omit any important points, I trust you will excuse me. I may also add that I am almost physically unable to say anything at all, and it is only because I promised Mr. Morrison and some others that I would address you that I have consented to make any remarks.

The time has come for us to look upon the distribution of power in a light altogether different from that in which it was viewed three years or even one year ago. We have heard about electric motors, and we have talked about the possibilities of the transmission of power ever since Pacinotti ran his first motor. But motors were run primarily with batteries, and it is only recently that they have been operated in connection with central stations.

They have been made of small sizes and treated as toys, and more batteries and motors have been invented than there have been made variations in the steam engine, but we have never reached any position from which we could show a commercial return from the use of electric motors until the last year or two.

The distribution of power by electricity, so long looked upon as a visionary and to-be-hoped-for attainment, is now an accomplished fact. It is in its infancy, but it has a future probably second to no other enterprise in the commercial world. It is not necessary here to give a scientific explanation of the operation of a motor. I will try to briefly show that electricity will fill the field in a far more complete and satisfactory manner than, but in very much the same general way as, does the distribution of power from a central station by means of gas, steam, water or compressed air. The use of any of these elements for this purpose is an engineering problem. To be successfully solved, not alone scientifically, but commercially, every part of such system must be in thorough accord with every other part. It is not enough that there shall be a good dynamo, or that there shall be a good motor, but that the dynamos and motors shall be built for certain specific electromotive forces definitely related to each other, and that the conductors should be put in for the distribution of given amounts of energy to the motors, under given losses, and the motors should have an efficiency that is not visionary or sought after, but which is just as well known as the characteristics of any part of the system.

In considering this question, however, we are confronted with grave responsibilities and many difficulties, and those who assume to advise the general public cannot be too careful of their utterances. We have to consider the state of the art and the people's knowledge on the subject. We have to even contend against the ignorance of people in charge of central stations, and we have to contend against a much worse element, the ignorance of the general public concerning electricity. With steam we do not have to deal with this difficulty at all. Trained and experienced engineers can be secured without number. They can be hired by the week or month to care for an engine, and since all engines are based upon nearly the same principles and are practically alike in their operation, no difficulty is experienced in getting good men to care for a five, twenty-five, fifty or a hundred horse-power engine. This is not the case with electric motors. We are obliged to depend upon the central station managers and those whom they especially train.

The practical questions which arise are: Who are to exploit this business? Who are to be actively interested in the extension of this system for the transmission of power?

There are two representative industries already in the field. The first to come was the arc light; then the incandescent light; and now, finally, comes the transmission of power for industrial purposes. There have, in consequence of the order of development of these three different methods of using electricity generated at a central station, arisen three different companies, more or less antagonistic to each other, but which ought to be working in harmony.

No one can doubt that if, ten years ago, the arc light in its present stage of development, the incandescent light in its present perfection, and the electric motor as efficient as it is to-day, were all three at the same time presented to capitalists as commercial investments, all three would have been taken up by the same men on a broad, comprehensive plan, and each would have held its own particular field and would have been pushed with the same energy and success that they have been individually; and that, instead of there being more or less of a rivalry between these three branches of industry, they would have been operated under one control, one general expense and one profit.

An illustration of their natural unity of interest is afforded by the action of the various companies representing these different branches. Arc light companies are operating incandescent light; incandescent light companies are running arc circuits; both are beginning to use motors; and I suppose some of the future motor companies may be rash enough to supply lights.

But since we have to deal with existing conditions and vested rights and privileges, let us briefly consider the various organizations which can be instrumental in developing this new field of work, and the methods by which they may be successful. As being in the position to actively take up this work, I may mention, first, arc light companies.

A very large number of existing companies have already secured free franchises which it would be difficult for other companies to obtain. Some of these companies are to-day just barely meeting their running expenses, because they are supplying power for lights for only a fraction of the day or night in close competition with the gas interests, and perhaps with other electric light companies. As the demand for light varies, of course, at different times of the year, the receipts vary above and below the operating expenses. All through the day, till perhaps five in the afternon, these stations lie idle. Such companies have their poles erected, their lines run, and certain franchises in their possession, and it would be an easy matter for these same companies to run lines for the distribution of power on the same poles as carry their arc light circuits. The wiring for this purpose would be very simple. In some cases the poles would have to be re-enforced; in others it would not be so. For running these lines to supply power alone, constant potentials as high as 400 volts could be used with perfect safety, and this would very much reduce the size of the wire.

As regards incandescent light stations, many of these run only in the daytime and do not begin their lighting until late in the afternoon. The bulk of their lighting terminates long before midnight. Other of these stations run during the day because they find the necessity of supplying a few lights in the daytime to get certain contracts for night work, but almost invariably this day work is at a loss. These companies already have their lines run to supply power on constant potential circuits, some overhead and others under ground. Since the power would begin in the morning and continue for a general average till the latter part of the afternoon, and then begin to fall off, and the light at the same time begin to come on, such a station, if worked up to its full capacity, ought to have an almost continuous load from morning until late at night; the load consisting first almost entirely of power, then of light and power combined, and finally, almost entirely of light.

The gas engine, although it has made great strides in England, does not stand in high favor to-day in the United States. A gas engine will not work up to the capacity at which it is sold and at which it is nominally rated. It will fall off anywhere from 25 to 50 per cent. below this. Its motion is necessarily irregular and uncertain, because during a large part of its rotation it is dependent upon the inertia of the fly wheel. Such machines are necessarily more costly than electric motors of the same capacity, such cost being about double. They are noisy, they cause a great deal of heat, and they are uncertain. Their advance in England was made before electric motors were as practical as they are to-day, and where gas is sold at a very much lower rate than it will be possible to get it for in the United States for many years to come. The electric motor, then, can easily compete against the gas engine when put side by side, both in initial cost and expense of operation. It is likewise more compact and has an excess capacity, a quality that is never claimed for a gas engine. Gas works have among their residual products coke, which is of very little value. By putting in good generators, running wires for the supply of power alone, and putting the generators and dynamos in charge of the men who are already employed at the gas works, they could produce their power and sell it at a very advantageous price. Their office rent, officials' salaries and attendance would be reduced to a minimum.

Special stations should be put in good manufacturing and industrial districts, and preparations made to supply any demand for power from a half horse-power up to one hundred or more horse-power. There is no possible question that, when a large number of motors are supplied from one district, even when dealing with large powers, electricity can successfully compete against steam.

Double circuits can be used, small powers being supplied at 100 volts and large ones at 400. Such stations should be built to get the steam power at the lowest cost, and hence should have the best engine and the best method of fuel consumption. The district covered will depend upon the location of the station. If this is central, two or four square miles can be easily covered.

I will now consider the different classes of circuits on which motors may be used.

First. Arc light, or constant current circuits, in which the current supplied to the motor is kept constant at a certain number of ampères, ranging from six to nineteen ampères in different systems. The electromotive force at the terminals of the motor varies with the load.

Second. Constant potential, or incandescent light circuits, in which the difference of potential at the terminals of the machines is kept practically constant while the current varies with the load.

Third. Circuits in which the current and the potential both vary, as is the case where there is an appreciable drop or fall of potential on connecting lines somewhat removed from the source of power of a constant potential system.

I am now operating on all classes of these circuits, but since, because of the small ampère capacity of the current on arc light circuits, any large power must require a great difference of potential at the motor terminals, and variations of power will cause sudden and great changes of

potential, the arc light circuits have principally been used in conjunction with arc lights for transmission of small powers only, or for constant work.

In considering the transmission of power as an industry, that is, in a broad and comprehensive way, and not as an adjunct to some system of lighting, I may here state that practical and theoretical considerations make it imperative that the constant potential method of distribution is the only safe and feasible one. Since I make this statement, it is incumbent upon me to explain the reasons. The only existing constant current circuits are used primarily for the operation of arc lights. At present, as I have said, these range in capacity from nineteen to six ampères. The unit of light which is required for general purposes necessitates an expenditure of about half a horse-power of electrical energy. A greater expenditure would be extravagant. In order to keep the size of the conductors as small as possible and to allow long extended circuits, the tendency is to reduce the ampères to the smallest number.

The conditions of an arc light probably will not allow this to go below about six ampères; the more ordinary unit is about nine and a half. The commercial conditions unquestionably will not permit, in the future, of a much higher ampère capacity, because the size of the wire varies as the square of the current used. Now with a nine and a half ampère current, a motor to develop one horse-power—supposing it to have an efficiency of eighty per cent.—must have supplied to its terminals 933 watts of electrical energy. In other words, there would be at the terminals of the machine an electromotive force of about 98 volts for each horse-power developed. Suppose, now, we want to transmit one hundred horse-power; it would then be necessary (if the motor be of the same efficiency) to supply to the motor 93,250 watts of electrical energy; and, if it were on this 9½ ampère circuit we would have an electromotive force of over 9,800 volts.

Now, in practice, arc light circuits vary from, say, 1,000 to 2,500 volts. On a 1,000 volt circuit you could recover about ten horse-power; on a 2,500-volt circuit about twenty-five horse-power. In other words, existing arc light machines, if devoted entirely to the transmission of power, are limited to the actual development, on even the largest machines in ordinary use, of twenty-five horse-power; and, if used in combination with light, there would not be available on any particular circuit over a small fraction of this. Now if you are going to consider motors as toys, if you are going to deal with the transmission of the tenth of a horse-power, or one-half horse-power, or a one horse-power unit, and are willing to have the element of danger as well enter into these small transmissions, then you can work with an arc-light circuit; but if you are going to transmit units of five, ten, fifteen, twenty, or twenty-five horse-power, you cannot deal with the arc-light circuit; it is utterly impossible.

In Boston we have recently put upon certain lines nearly two hundred horse-power. Suppose this were supplied on 9½ ampère circuits. No less than eight circuits of 2,500 volts each would be required, and probably more, because with units as high as fifteen horse-power and this division of circuits, the law of general average could come into play in but a very limited way.

These eight 2,500-volt circuits represent the capacity of a 460 arc lamp station, and to deliver the power not a single lamp could be used at the same time. Does any one really suppose that by this method of working, leaving out for the present all question of danger and unreliability, the same results could be obtained as are in fact to-day? The constant current method of distributing power is the limited and unnatural method; the constant potential, the comprehensive and natural method. This is a fact entirely independent of the question of relative electrical potentials, because on the constant potential circuit we can work at 100, 500, 1,000 or 2,000 volts if we please.

In Boston we at present transmit up to 4,800 feet on a 200-volt circuit.

When dealing with the question of power alone, and with an area of, say, four square miles, the station being near the centre, I would prefer to work with 400 volts. Remember then, that power transmitted means the transference of a given number of watts of energy. It is expressed by two products, quantity and pressure. If one is increased, the other may be reduced. If small conductors are to be used, then it is essential that small currents shall be used, and of necessity high electromotive forces, even when operating on a constant potential circuit.

When dealing with short distances and small powers it is better to use low potentials; but when dealing with large powers and long distances it is absolutely necessary to use high potentials, because the commercial conditions will allow only a certain proportionate investment in copper. There are certain laws to which it is well to call your attention, as they may serve to make more clear some of the questions which come to you.

First, with any given work done by a motor, loss of power on the lines, electromotive force at the terminals of the motor, and distribution, the weight of copper varies as the square of the distance. That is, if the distance is doubled with these given conditions four times the weight of copper will be required.

Second, with the same conditions, the weight will vary inversely as the square of the electromotive force used at the motor. That is, if using double the electromotive force at the motor, it is necessary to use only one-quarter of the weight of wire. Another way of expressing this is, that if the weight of copper is fixed, then, with any given amount of power transmitted and a given loss in distribution, the distance over which the power can be transmitted can be increased in directly the same ratio as is the electromotive force; for example, if a thousand pounds of copper is required to transmit a given amount of power with a given loss, and it is desired to double the distance with the same weight of copper, then the electromotive force must be doubled. Again, with the same cross section of conductor, the distance over which a given amount of power can be transmitted will vary as the square of the electromotive force. Another way of expressing these laws is by means of a formula which I have been using for a long time, and which you will find of service in determining the size of wire to use in the transmission of power. Let

l = distance between the generating and receiving stations in feet.

n = number of effective horse-power to be delivered on the motor shaft.

E = electro-motive force at the terminals of the motor.

v = number of volts fall of potential on the line.

$E + v$ being, of course, the electromotive force at the beginning of the line.

K = efficiency of the motor.

$C\,M$ = circular mils of conductor.

Then, allowing 10.5 ohms as the resistance of a mil-foot of commercial copper, and considering a complete metallic circuit, we have

$$C\,M = \frac{15{,}666 \times n \times l}{E \times v \times K}$$

Let me give you a practical illustration. Suppose we have a motor the efficiency of which is ninety per cent. at 400 volts electromotive force and when developing ten horse-power, and that we wish to transmit this ten horse-power 5,000 feet from a station, and elect to lose about nine per cent. on the line.

Our initial electromotive force will be 440 volts, and we would have

$$C\,M = \frac{15.6 \times 6 \times 10 \times 5{,}000}{400 \times 40 \times .90}\text{; or,}$$

$C\,M = 54{,}396$, which is about equal to a No 4 B. W. G.

This electromotive force of 400 volts is a very good standard. Without serious inconvenience we can go to 600. For long distance special transmission it is necessary to go up to 3,000 or 4,000. If the arc light current be used, all motor handlers take the risk of high potentials.

As I have already said, you have to contend against the ignorance of people using motors. It has been said that you can put a motor on an arc light circuit, and it will take care of itself; that the people at the central station will take care of it. This is true to a certain extent and to an equal extent it is not. I came very near having a serious accident in New York. I was working on a Brush circuit of 2,500 volts. I took hold of the motor and began to adjust the brushes, at first unintentionally and finally intentionally; but it so happened that I was not in a position to be grounded. Had I been so and there had been a ground on the line some distance away, there would have been an end to my motor experiments. A similar end would have resulted if I had lifted the brushes. We put in an automatic cut-out to avoid that danger. We found that a man blocked the cut-out so that it would not work. If that motor and cut-out had any trouble with it (it was on one of the most important Brush circuits in New York, one fifteen miles long) it would have caused the blocking of the entire line.

With a constant potential circuit this kind of trouble is practically impossible. If there are grounds anywhere on the line, or any defects in the motors, they will cut themselves out of circuit automatically, and the rest of the circuit is not affected.

Mr. SPRAGUE here stated that he would be glad to answer any questions members of the convention might ask, because in that way perhaps he would confine himself to what would be of most pertinent interest.

Dr. MOSES: Will you be so kind as to tell us something about the cost of motive power?

Mr. SPRAGUE: It is plain that in New York City the New York Steam Company is furnishing power to 435 engines. That power is supplied from a big steam station in Greenwich street. The conductors or pipes used for conveying the steam are, of course, of very large dimensions. The steam when delivered to the engine is wet steam, and the pressure is about 80 or possibly 90 pounds. There is one point of great advantage in the electrical transmission of power, in that you can work at so much higher electrical pressure than you can steam pressure. Then, again, the cost of conductors for electrical transmission is very much less than the cost of conductors for the transmission of steam, and you have not the objectionable element of wet steam. Yet here is the fact that the steam company is furnishing 435 engines with power and is making money. The consumers find it cheaper than they can generate their own steam. We found it necessary in dealing with the various light companies to have certain facts in our possession as to what we could do if we had 500 or 1,000 horse power in a central station, as to how much power we could contract to deliver, and how much could we get for it. The manager of the Edison Central Station, in Pearl street, New York, insisted that the meter was the proper means of determining what must be paid for power. If a man uses his motor, the meter registers against him. This was done on our motors. He charged 1⅞ cents per ampère hour, and he thought he was going to have a bonanza. And so he would have had if the motors had not been automatic. After four or five months' running, we went to these people and asked them to let us see copies of their bills. We found some curious facts. I will cite one instance as showing the economy of the transmission of power by electricity:

There is a firm of chemical dealers, James L Morgan & Co., No. 47 Fulton street, New York, who are running a freight elevator. They have a 3 horse-power motor working up to 4½ horse-power capacity. Their bills average about $12.50 a month; that is $150 per year. Had that motor been used, not up to 4½ horse-power capacity, but simply to its normal capacity of 3 horse-power, steadily ten hours a day, their bills would have been about $1,200 a year. So you see the average percentage of the time for which they use the motor is less than 15 per cent.

There you have an example of a motor, the people using it as they please, as many hours a day as they please, and they find by their meter bills that they only use that motor to fifteen per cent. of its capacity. Now, we took a great many of these cases, printing offices and burnishing machines, etc., sometimes where they ran continuously and where we knew the machine was oftentimes overloaded, and we found this simple fact, viz., that with the whole capacity of motors, they average not over 33 per cent. of their capacity. In no case did we find, where they used the motor without any let up, that their bill was more than 51 per cent. of the capacity of the motor.

Mr. DE CAMP: Will you allow me to ask you as to the distribution of the business? Was it distributed among the class of people making up the general community?

Mr. SPRAGUE: Yes, sir.

Mr. DE CAMP: How many users did it cover?

Mr. SPRAGUE: I do not know; but it is a thing which holds, no matter how many we take. We took specimen classes of work, that is, elevators and burnishing machines, and work of that kind. All our records, however, go to show that motors, as a rule, do not average over 33 per cent. of their capacity for the ten hours of a working day. This, in fact, is a large average. This may to a great extent be understood from the following statements: A motor is absolutely automatic. The total current used in machines of the high efficiency which we make is almost directly proportional to the work done at any instant. The result is that if the work slacks for a moment so also does the current. Almost all work is spasmodic in character. Motors have to be put in for their maximum capacity, but not one class of work out of a hundred, with the exception of ventilation, offers continuous duty. Some motors are stopped, and in others which are running the work is constantly varying from the maximum to the minimum. An illustration of this may be cited in the case of elevators. If twenty elevators, each requiring a maximum of five horse-power, were driven from the same line of countershafting, they would not require an engine of over forty horse-power, because some would be going up, some going down, others standing still, and in not two cases out of the twenty would simultaneous trips be made, while in not one trip in five hundred would an elevator be hoisting its maximum load from the basement to the loft. Comparison also may be made with existing incandescent light plants. Practical experience shows that not over 55 or 60 per cent. of the total number of lights in use in a station are used at any one time, although it is possible to use them all. But incandescent lamps when they are in use take their full amount of current. Not so with motors. A certain percentage of the motors, just as with the lights, would not be in use at all, and in most of those in use the current would be continually varying, just as if the lights of an incandescent light station were being turned up and down from one to sixteen candle power, as well as many of them being turned out. The recovery in an ordinary district with 88 to 90 per cent. of the power delivered to the dynamo pulleys converted into electricity on the line and 10 per cent. loss in distribution is about 65 per cent. This 65 per cent., however, where the work is distributed, is only 33 per cent. of the capacity of the motors for which power can be contracted. In other words, for every 100 horse-power in a central station, 65 horse-power at any one instant can be delivered under an ordinary distribution, and this 65 per cent. is only one-third of the power which can be contracted for provided there are a large number of motors in use. Of course where only one motor can be used, then 65 horse power only would be obtained, but the object of the central station is to take advantage of all the falling off of work, and that it can be done is shown by the records which we have of a large number of motors in use. The question then for central station managers is not how much can they afford to supply one, two or twenty horse-power in a single instance, assuming that to be the only power delivered; but for how much they can afford to deliver power provided the full capacity of a certain engine is taken up by a number of motors.

The introduction of the electrical transmission of power into Boston was accomplished by the personal efforts of the president of our company, myself and our agents. The Boston company were not required to take any steps except to run their wires. We agreed to pay them $125 a horse-power per year—a pretty good price for us to make a contract for. The steam power actually costs the company about $30 to $35. Mr. Harding, then our New England agent, and now our general agent, started out to rent motors, charging $150 a year for horse-power. He pretty soon made up his mind that he would *sell* the motors. Every one put in during the past three months has been sold. In that one station there are nearly fifty people owning motors varying from ¼ to 15 horse-power. That shows we have passed the experimental stage. We are no longer dealing with toys or theories. We are dealing with the commercial exploitation of the transmission of power. In New York City we are going to introduce motors to run the largest Hoe printing presses. We are going to prove that in dealing with these large powers we can do it more economically than it can be done by steam engines.

Mr. DE CAMP: Do I understand that in case I had 100 horse-power in my mill it could be furnished cheaper from an electric motor than it can be furnished by steam?

Mr. SPRAGUE: Yes, if you are running in connection with a central station. Large engines can be operated and large powers developed under as little general supervision as smaller powers, and under far less supervision than several units of smaller powers. The cost of such generation of power is much less in larger engines, both in the amount of coal and water used and in the matter of attendance, and also in the general expense. It follows, then, that if the power of a manufacturing district can be centralized, it can be developed at a much higher efficiency and at a very much lower cost than where it is being generated in a large number of units. If, now, this power can be sent out or distributed to a large number of users in the district, then, supposing that only the same amount of power is sold as is generated in the central station, this plan of generating power would still have the advantage in point of economy. But when it is taken into account, as has been shown, that where power is distributed to a large number of users from a central station, this station can take advantage of the very large falling off in the use of machines, it at once becomes apparent that if the system is properly constructed and operated, there is not only not a loss, but a great gain, in the centralization of steam power, and this will hold true whether dealing with a central station of 100 or of 10,000 horse power.

A MEMBER: Mr. Sprague, what about the question of heating mills?

Mr. SPRAGUE: Mills are not obliged to use exhaust steam; there are several other ways of heating them. I am not advertising any particular method.

Mr. RIDLON: Mr. Sprague, do you think it is possible with a water power of 700 horses that is a mile away from a mill to generate 150 or 200 horse-power as cheaply as by steam?

Mr. SPRAGUE: Yes. Of course the original investment would be more, because you would have to put in a generating station. Water power is not the most reliable thing in the world; I would rather depend upon steam. It is a question of cheap fuel. Get as much money for power with the least possible expenditure. Water power is all right provided you have plenty of it. I am going to start a central station in New York (provided the three-headed Commission we have there will allow me) of 500 or 600 horse-power and working at 400 volts electromotive force, and then you will see the truth of what I tell you.

Mr. RHODES: Is it possible to transmit water power to a distance, say, of 10, 15 or 25 miles?

Mr. SPRAGUE: Yes, sir. There is this element to consider in the transmission of power; it is just as practical a question as the transmission of energy by any other means. The moment that the interest on your plant and the depreciation and the cost of operating exceed or equal the cost of production in the central station, just that moment do you want to drop the transmission of power.

That is, in other words, if you want to go from A to B, and that is a distance, say, of two miles, you can transmit that at a certain pressure and a given investment. If you want to go ten miles, then the question comes in, will my investment and the depreciation cost me more than if I generated my power at that point, no matter whether it is by steam or water. I know there is a great deal of talk about transmitting the power of Niagara Falls to New York City. It never will be done in this wide world. The transmission of power even ten miles will not pay except in special cases, as coal is too cheap. I am just as practical on that question as any man can wish me to be.

As an instance of the tremendous field which opens for special work, I will mention one case in which we have submitted an estimate for transmitting 200 horse-power over sixteen miles, and we have been asked to consider, also, a proposition for transmitting 600 horse-power twenty-two miles. In these cases the investment, of course, is very large. It is necessary to work with very high electromotive forces; but as to the commercial value of such transmission, you may judge from these facts: In the case where the 200 horse-power is desired to be transmitted sixteen miles they are now operating a 100 horse-power engine to supply power in three or four levels down in the mine. They do not receive over 40 to 45 horse-power. Coal of a poor quality costs about $22 a ton, and wood costs $11 a cord. It costs about $150 a day of twenty-four hours to operate this 100 horse-power engine from which only 40 horse-power is received. Sixteen miles away an ample water power is found in a river running down the side of the mountain. Here is a special case where the transmission of power, even with a very large investment, would result in a great saving.

The conditions of mining in the West present a great many similar cases. The mines are oftentimes on the brows of hills, with water power only a few miles away, but utterly inaccessible because of the difference of levels. I think that this field of work is going to present some of the largest opportunities for the transmission of power.

Leaving these special cases of transmission for consideration at another time, the question is whether you are going into the transmission of power in a half hearted manner, making it simply an adjunct to some existing circuit which you have, or whether you are going to take up with the energy which characterizes the treatment of the arc and incandescent light problems, and, recognizing the breadth of the field in which you have to work, enter into it in the spirit which guarantees success. To do otherwise is to invite failure. You must deal with the transmission of power the same as with any other business which is successful, exercising the same energy, watchfulness and enterprising spirit.

As I have told you, the practicability of the transmission of power is proven beyond all possible question. I am running now, I suppose, motors in twenty different cities in this country. I have never seen over one-tenth of them in operation. These motors are used not only in the United States, but we have introduced them into the Argentine Republic. Germany, Italy and Canada, and are about to introduce them into China and Japan. So you see it has gone far beyond the experimental stage.

Mr. WEISSLEDER: How about running a street railway where the conductors are six, eight or ten miles long?

Mr. SPRAGUE: We have to work at a potential of four, five or sometimes six hundred volts to get the highest economy in the transmission.

Dr. MOSES: In running your motors at this very high electromotive force, do you feel perfectly confident as to the vitality of the machines?

Mr. SPRAGUE: There is a limit to the electromotive force which you can use. In going to 7,000 volts I think M. Deprez has exceeded the commercial limit. All things being considered, I think 3,000 volts sufficiently high.

Mr. RIDLON: Would it be any better to use an alternating current than a constant current; the regular arc current of to-day?

Mr. SPRAGUE: While I believe it is possible to run motors on alternating currents, I have not gone far enough into that to state what the results have been.

Mr. RIDLON: Would it be of any assistance in running motors on an arc light circuit to use a distributing box, or to use it on an alternating current?

Mr. SPRAGUE: No, sir. I do not deny the possibility of running motors on arc light circuits. We are running on that class of circuit, but it is a limited field.

A number of questions were put to Mr. Sprague, which were finally summarized by Mr. Morrison as follows: It is not the intention of any of those present to discuss the motor business as a business exclusively. The question is whether they can take any part of the motor business at a profit, their business being arc lighting. Now, having a surplus of power, can that power be utilized at a profit to arc light companies? They do not propose to buy any more machinery; they do not propose to build additional lines, but to utilize the dynamos they have and to utilize the power they have.

Mr. SPRAGUE: Unquestionably they could do that, but that limits their capacity, and it makes the motor business simply an adjunct to electric lighting. Now, that is the great fault with many Edison stations I have had to deal with, making the motor business an adjunct to the electric lighting business. If one station I have in mind had taken the capacity of their station a few weeks ago, and run it for motors, they would get double the amount they are getting for light to-day.

Mr. POWERS, of Troy, N. Y., stated that he had started an arc light circuit for the purpose of supplying motors. A very large proportion of the power they would have to supply would be from 5 horse down. The difficulty they have met is how to reconcile the first cost of small motors used in parallel distribution on a 600 volt constant potential circuit.

Mr. SPRAGUE stated that with the distances in Troy 600 volts was unnecessarily high. Under suitable electromotive force the constant potential circuit would be found to be the cheaper. He said that he was considering the question of large powers and large areas and that he was not content to deal exclusively with small powers. The tendency is to increase the powers of motors used. In Boston the motors used were first of ¼ horse-power; now they are run from ¼ to 15, and very soon will be higher.

Mr. LAW: This motor question resolves itself into this: A majority of those here are placed in this position. We have a certain number of arc circuits up; these circuits are not full of lights. We are not allowed by the laws of the city to place any more wires on the street. Now, the question is, Is it going to pay us to put in motors or not?

Mr. SPRAGUE: Unquestionably, yes; put all the motors you can on your circuits; the best motors you can get.

A MEMBER: How are we going to get at a method of charging for them?

Mr. SPRAGUE: That depends a good deal upon the local management. My principle is to get all you can for them.

A MEMBER: You say you are running them on incandescent circuits in New York? What effect have they on the lights and have you any system of regulation for maintaining constant speed.

Mr. SPRAGUE: As we are building our standard machines, they will run at the same speed, that is within 1 per cent., under all loads up to the maximum. The machines are absolutely automatic. The large machines are of 91 per cent. efficiency. Not only that, but we have machines which run on a potential varying from 180 to 220 volts; that is, on a variable constant potential circuit, if I may use the expression. In Boston, we had one machine built for 110 volts running at 190 volts; in another case a machine for 110 volts was run on a circuit that dropped to 60 volts.

This regulation depends upon the winding entirely. A machine wound on similar principles will run at a constant speed on a constant current circuit, but only when working below 50 per cent. efficiency. If working above 50 per cent. efficiency, an automatic mechanical governor is required. No matter what certain English scientific writers may say, it is impossible to wind a machine to run at a constant speed under variable load on a constant current circuit and work above 50 per cent. efficiency.

Mr. DUNCAN: We have a 60-light machine of about 2,500 volts. I am informed that we could deliver from that machine about 45 or 50 horse-power; take that as a figure. Can we run such a motor?

Mr. SPRAGUE: You can contract to deliver that number of horse-power, if there are a large number of small motors, on account of the intermittent use.

Mr. DUNCAN: We have a 2,500 volt arc light machine. Now can we run a 45 horse-power motor, that is, one machine.

Mr. SPRAGUE: No, it would be utterly impossible.

Mr. DECAMP: Now, wouldn't it be better for us to put in a machine such as you recommend and double our wire and run the same amount of power? I am assuming that we have one machine on a circuit. We have another wire on the circuit. We couple those two wires together, making double, and reducing the potential at the machine. Can it be done economically?

Mr. SPRAGUE: If you will give me the exact condition of the circuit I will tell you.

Mr. DECAMP: Suppose each circuit is five miles long.

Mr. SPRAGUE: How much power are you willing to put behind the machine?

Mr. DECAMP: The same power as we use to run the machine for arc lights.

Mr. SPRAGUE: It will be necessary to have the full detail of your proposition before I can give you a definite answer.

Mr. WHEELER: Why is it not as well to run out independent circuits for large powers and work on constant current circuits.

Mr. SPRAGUE: With equal total electromotive force, the weight of wire would be the same, but with the constant current you would have a large number of circuits, the regulation would be far more difficult, and the advantage of intermittent use would be lost. There are many other objections, but these ought to be enough.

After some further discussion as to the practicability of supplying power from a constant current station,

Mr. MORRISON said: Mr. Sprague takes the ground that a successful motor service should be run from a central motor station. All of Mr. Sprague's argument is that the motor business pays better than the electric light business, and I think that he has proven that very satisfactorily by the figures he has given you. But it does not entirely solve the question which is being discussed here, how arc light companies can utilize their surplus current. He told you that if he had a company that had spare power he would use it. There is another thing here, he does not care to deal with small motors. He prefers the larger sized motors, and I think he is very sensible. If you come to 1 horse-power motors and ¼ horse power motors, they can be put upon the arc light circuit; if you are going to abandon the electric lighting business and go into the motor business, then take the plan that Mr. Sprague suggests.

Prof. Houston having been introduced by the chairman spoke as follows on

THE FUTURE OF ELECTRIC MOTORS.

I have not very much to say on the subject of motors, but it seems to me of all the bright future which seems to be in store for us as those interested in electrical matters, that in the direction of electric motors the sky appears to be the brightest. For, when we bear in mind the economy which is possible in the electric motor (and I was glad to hear Mr. Sprague speak in such unqualified terms respecting it); when we consider the very great economy of the electric motor, its small bulk and the wonderful power it is capable of rendering, it seems to me that comparatively little is needed in order to permit the steam engine to become a thing of the past, and the dynamo-electric machine become the motor of the future. Of course, as we all know, such a state of things would be impossible as long as we have to rely upon the steam engine as a prime motor to furnish the electric current; but I take it that inventive genius will not be found long wanting to devise a practical means whereby the burning of coal can be directly applied to the production of electricity; and as soon as that is accomplished, then beyond any question the steam engine becomes a thing of the past—a toy—an historical piece of apparatus. And ye, fellow workers, know what that means; ye engine and boiler men know what that means—when you can pack on a small floor space a machine capable of developing three, four, five, six, seven thousand horse-power if you only have the wherewith to put into it. I think the chances are that that will be solved. I think the chances are good, and that it will be made when one succeeds in solving the problem of how to change a current of low electromotive force into one of high electro motive force.

It is recognized to-day that coal can be burned to produce electrical power, and I do not think it requires any great prophetic power, looking into the future, to see that this is not only a possibility but a probability—and of the near future. I confidently expect to live to see it.

When it was proposed to cross the Atlantic by means of steam, it was shown beyond peradventure by the very best mathematical ability, by the highest engineer-authorities in the world, that it would clearly be impossible for a vessel ever to cross the Atlantic Ocean by means of steam, because, as it was argued and proved, the coal necessary to supply such a vessel would sink the ship.

Now, gentlemen, on exactly the same plan, is it not true—will you excuse me if I vaporize a little—that the only thing that stands in the way of aërial navigation to-day is compact motor power? We can certainly fly, and we can certainly navigate the air, not by means of balloons, but by some motive power, if we can get a compact motor. It seems to me not only possible, but very probable, that the electric motor may solve this particular requirement. It may not be impossible that we shall live to see flying. I certainly expect not to fly myself, as that would require considerable power, but to see machines carrying their passengers through the air.

It does seem to me that of the attractions of this field, the most practical and the one in which the future is brightest to us, is in the direction of electric motors; and I believe, too, in electric motors on arc light circuits, even electric motors in series as well as electric motors on constant potential circuits.

THURSDAY MORNING SESSION.

At the opening of the session Mr. F. H. Ball read the following paper on

CONVERTING THE HEAT ENERGY OF COAL INTO ELECTRICAL ENERGY.

I have been very much interested in the proceedings of this convention, and it being my first appearance as a member, I have, with some hesitation, asked your indulgence, promising to be brief.

A subject which cannot but interest us all is the transformation or change of the heat energy of coal into electrical energy. The present method of this change by means of the steam engine and boiler is attended by such an enormous loss that there is room for a correspondingly great gain. It is a remarkable fact that the changes from dynamic energy to electrical energy and from electrical back to dynamic are attended with no such loss. It is well known that an electrical dynamo will transform a very large percentage of dynamic energy into electrical energy, and Mr. Sprague told us yesterday that an electric motor will change 90 per cent. of electrical energy into dynamic energy. We saw last night at the Franklin Institute that electrical energy may be stored and afterward return 80 per cent. of the amount so stored, leaving a comparatively small loss in these changes, but unfortunately we must first obtain our energy from the heat energy of coal, and in this process the loss is enormous.

First we lose a large amount of heat which passes up the chimney and we are unable to make our boilers absorb. This I think our friend Mr. Upton will admit, even with the Jarvis furnace. Then we find a still further loss by radiation. The greatest source of loss, however, is in the inability of the best types of steam engines to transform any considerable amount of the heat energy of steam into dynamic energy delivered to the belt. Then we have the still further loss (although small) in changing dynamic to electric energy by the dynamo, so that it is questionable if more than 5 per cent. of the energy of coal can, by the best known methods, be transformed to electrical energy. The remaining 95 per cent. is what we are all after.

To utilize any considerable amount of this waste means not only to supersede the steam engine, but to entirely revolutionize most of our present methods and appliances, and make many things possible that are now impossible. That this will be done sooner or later seems at least possible, and let no man risk his reputation as a prophet by saying that it will not. If a process is never discovered by which the loss attending the transformation of heat energy into electrical energy may be reduced to correspond with the loss in changes between the other forms of energy, it may be that a very large reduction of this loss, effected by some inexpensive converter, will still supersede the steam engine or make a formidable rival. The steam engine has done a wonderful work, nevertheless, and when we consider that it has been a successful competitor with nature's water powers, we shall remember it kindly for the good it has done when we lay it aside.

And now, gentlemen, with your permission, just before we lay the steam engine aside for direct conversion of heat into electrical energy, I want to announce that a discovery has just been made which may be of interest to this convention. This will be its first public announcement before appearing in the electrical and mechanical papers. The discovery is in the direction of bettering the performance of steam engines by obtaining a more uniform speed under varying conditions of both load and boiler pressure. The better class of engine builders have been in the habit of claiming that their engines would govern within a range of 2 or 3 per cent. up to the rated capacity of the engines, which means 5 or 6 per cent. before the ultimate capacity is reached.

The discovery to which I have alluded wipes this out entirely.

The matter is one of too great importance to be confined to any one type of engine or even to any one builder, so that engines of the various types and sizes will now be offered under contract by their builders by which the engines are absolutely forfeited to the purchaser if any change of load or of boiler pressure shall change the speed of the engine even *one* revolution, provided the load is not beyond the maximum capacity of the engine.

The PRESIDENT pointed out that the loss referred to by Mr. Ball would apply not only in the case of any dynamo operated by steam, but in that of a flour mill or a cloth mill, or any other mill using steam direct. The fault lay with the engine, not with the dynamo, whose efficiency of conversion was the highest possible.

Mr. BALL admitted this, but in reply to questions from Mr. Morrison and Mr. Wetzler said he did not feel quite at liberty yet to state what was his improvement in engines relating to the governor.

The secretary read a communication from Mr. C. J. Van Depoele to Mr. G. S. Bowen, as to the success of

THE ELECTRIC MOTOR APPLIED TO STREET CARS.

Referring to the rapid progress which had been made in this branch of electrical science, Mr. Van Depoele stated that hardly a year had elapsed since the propulsion of street cars by electricity was merely an experiment, and that since then the most sanguine expectations of the projectors had been realized. He said that the electric motor was sure to introduce itself even more readily than

the electric light on account of its economical and practical features. As an illustration of what had been done, he said:

Undoubtedly the heaviest work ever done by electricity anywhere has been in the city of Minneapolis, Minn., where an electric locomotive of 8 tons weight was used for over a period of about ten months, bringing ordinary railroad trains in the city, the steam engine only being allowed to come within a certain distance of the town. The cars used on this road are 11 tons in weight empty, and the train consisted generally of from 2 to 4 of these cars, and in the summer time were always crowded to the utmost capacity. This work of bringing in and out the trains began at 6 o'clock in the morning and stopped at half-past 11 at night. The number of trips made per day was 48. The amount of coal consumed was 3,500 pounds per day of 18 hours. An ordinary dummy engine doing the same work used over 3 tons of coal per day. Thirty-five hundred pounds of bituminous coal at $2 per ton will cost $3.50. The steam dummy burning 3 tons of anthracite coal at $6 per ton costs $18 per day, and a comparison shows how much was saved by the use of the electric motor.

The letter also called attention to the success of the writer's system at Detroit, Appleton, Port Huron, Scranton and other places where he now had roads in operation.

Mr. B C. Smith, of the Auburn (N. Y.) Electric Light Company, wrote wanting to know the best governor for water-wheels for electric light purposes.

Mr. Joseph Wetzler, of The Electrical World, then read the following paper on

INCANDESCENT LIGHTS ON HIGH TENSION CIRCUITS.

The demand which the public makes for electric lighting must be satisfied, and although the arc satisfies it to a considerable extent, experience has shown that the incandescent light is in equal demand and that arc light stations are called upon to furnish it. The service is found to be equally as profitable as arc lighting, and hence the introduction, by way of necessity, of incandescent lamps on arc circuits has become quite general.

The object aimed at is to reduce the quantity of copper required for the distribution of the current to incandescent lamps. This is accomplished by increasing the electromotive force employed on the circuit, and reducing correspondingly the total current required.

The various ways in which this may be carried out, it is proposed to give a résumé of in the following, so that those interested in electric lighting may become acquainted with what has already been done and suggested. It will be necessary at the ou set to state that it would be injudicious to assume that any one system is given as a perfect solution of the problem, for the conditions of service vary so much in each case that where one system would be a success, another might prove a failure. In other words, we must look at the question in a broad light and consider that all of these systems have their field of application, which depends alone on local circumstances.

Very early in the history of electric lighting Mr. Edward Weston proposed the placing of incandescent lamps in multiple series, by means of which they could be connected to a high potential dynamo. He was followed by others who adopted the plan of inserting the incandescent lamps in arc circuits. The usual method of doing this, as you all know, consists in employing a "distributor," which. generally speaking, is a device for connecting incandescent lamps in multiple series on an arc circuit, and which contains mechanism for preventing an increase of current when a lamp breaks. These devices, of which there are several forms in use, among them those of Brush, Slattery, Little-McDonald, etc., need not be more particularly described here, as they are already known to all of you. They are of undoubted value, but they cannot be said to wholly satisfy the general wish of electric light men for maintaining incandescent lamps on high-tension circuits.

The question then arose, How can the field of incandescent lighting be broadened so that the benefits of small-wire circuits can be taken advantage of, and so that the electric light can in the fullest sense take the place of gas as an illuminating agent?

This question can be answered in a variety of ways, each of which may be correct. I will take up the discussion by presenting the most simple case, and that is, the running of incandescent lamps in plain series, similar to the disposition of arc lamps. This has been successfully accomplished in one way, in what is known as the Edison municipal system. If we examine into the conditions under which this system can be operated, it appears that we have here a field which is well worth looking into, and as it has not, to my knowledge, been brought prominently forward, I propose to give a few details of what can be accomplished by it. One of the main objects for which the system was devised is the displacing of the street gas lamps. As such it evidently comprises in itself the use of very long circuits, and their economical operation is a first consideration.

The dynamos employed for this service have an E. M. F. of 1,200 volts, which allows for any drop in potential that may be desirable up to 17 per cent. in the wire, while a pressure of 1,000 volts is left to be expended in the lamps. The largest type of dynamo constructed for this system can feed 12 distinct circuits, upon each of which about 65 lamps of 15 c. p. can be placed, or 800 lamps in all. Each of these circuits carries only a current of 4 ampères, so that only a very small wire is required to convey the current, a No. 12 being generally employed.

With twelve circuits at our disposal from a single dynamo, it is evident that a wide range of distribution is possible, and the small cost of conductors is a decided advantage. Then, again, the system permits of placing lamps of greatly varying candle-power anywhere in the same circuit, ranging as high as fifty candle-power. Thus, each circuit is capable of feeding lamps aggregating 1,000 candle-power, whatever be the illumination of the individual lamps employed. This gives a basis of calculation upon which definite results can be quickly predicated.

The system such as it has been outlined here, is in operation in various cities, among them Portland, Me., where 500 lamps are so connected; Lawrence, Mass., with 550, and Denver, Col., with 530. While it is principally designed for street lighting, the system is also adapted to interior lighting where the load is a constant one, as in stores which remain lighted up to a fixed hour in the evening.

A system similar to the one described has recently been put in operation by Mr. Chas. Heisler, in St. Louis, and also in Vincennes, Ind.

A recent interesting modification of the method of running incandescent lamps in series has also been brought out by Mr. Alex. Bernstein in England. His method consists in utilizing the full arc current of about 10 ampères as ordinarily employed and running incandescent lamps of low resistance which require only 6 volts E. M. F.

Thus with an arc dynamo developing 2,000 volts, over 360 lamps could be placed in series. Several installations on this plan have recently been started in England and with reported good success.

A still more recent method of similar design is that of Prof. Elihu Thomson. This also consists in doing away with distributors and placing incandescent lamps directly in series in the same circuit with arc lamps. These lamps take the full current, and lamps of different candle-power can be inserted in the same circuit. In all these systems, provision must evidently be made, and now is, for preventing the interruption of a circuit when a lamp is extinguished.

There are still other methods of intercalating incandescents on high potential circuits. One of these is by means of induction through what are called secondary generators. As I understand that another member has prepared a paper dealing with this highly important branch I shall leave it with the bare, mere mention and draw your attention to a second method by which induction can be utilized for running incandescent lamps direct on arc circuits. This is the method devised by Mr. Ph. Diehl, which has lately been made public. The incandescent lamps in this system are arranged in two branches, between arc lamps, and a current interrupter is so arranged that the current is alternately broken in one set of lamps and simultaneously sent through the primaries of the other lamps. Thus the main current remains continuous and unbroken, while the rapid interruptions in the incandescent branches induce the current required to bring the filaments to incandescence. Lamps of any desired candle power can thus be easily inserted in the circuit.

This outline of the principal systems will give electric light men some idea of the various methods by which the incandescent light can be brought into service without the necessity of employing large conductors.

Thus far, I have only alluded to methods where the connection between dynamo and lamp is a direct one, but there are still other methods which come under the title of this paper, but which have hardly yet forced themselves upon the attention of those present. I refer to the use of storage batteries as an adjunct to the electric light station. You will probably all remember that when the storage battery was first brought out permanently, it was said that each house could now be provided with its quota of batteries, which, being charged from a central station during the day time, could furnish current for the lamps in the hours of darkness. During the past few years, when the storage battery has been in a state of slow evolution, this idea has almost fallen into oblivion, but I think the time has arrived when the problem should again be attacked in earnest and be brought to a practical solution. The reliability of the storage battery is now beyond cavil, and it only remains to work out the details. Let us glance for a moment at the method employed here and see what it involves. In the first place, your arc light dynamos, which now lie idle on an average sixteen hours out of the twenty-four, could be run practically during the whole twenty-four hours, charging the batteries in the circuit in the houses during the day time and doing their regular lighting as usual at night. Thus no additional machinery or boilers will be required.

Considering the installation in each house, all that would be required would be a battery of accumulators which, for economy of current, should have an E. M. F. of about 60 volts. This would be reached by 30 storage cells, which can be placed on a shelf in the cellar. Such cells, which can now be obtained in the open market, would be capable of furnishing current for 15 lamps and one charging of 12 hours would, with the ordinary number of hours of lighting, last for 3 days, provided all of the 15 lamps were lighted at the same time. Where the number of lamps is less, the time required for the battery to become discharged would be still further prolonged. A dynamo of 3,000 volts, E. M. F., and having a current of 20 ampères for your purposes, or two arc dynamos, giving each a 10-ampère current, coupled in parallel, would be able to furnish current for 50 houses, each absorbing 60 volts, E. M. F. The conductor required for the purpose need not be greater than a No. 4 B. & S. wire. To make the system perfect, suitable automatic switches can be arranged in each house, which would cut out the battery when the latter is fully charged and throw it into circuit again when discharged. In this manner it is probable that considerably more than 50 houses could be supplied from a 3,000-volt circuit, as not all of the batteries would be exhausted or charging at the same time.

Here, then, is one method by which, without a very greatly increased expense, the earning capacity of electric plants can be increased, and I believe the time has come when you should seriously consider the working of the field here presented.

But there is still another way in which the storage battery can be made to do good service for incandescent lighting from arc light stations. As stated before, the dynamos at the station are idle for a large fraction of the day. Now, nothing would be more simple than to charge the storage cells in series at a station during the daytime, and then couple them in quantity, so that they could be connected to incandescent circuits radiating from the central station, which would thus be virtually a secondary battery station.

It is a well-established fact that incandescent lamps are not used on an average more than four hours per day, the current required in incandescent circuits during the remaining twenty hours not reaching 15 per cent. of the maximum called for during lighting hours.

Let us again take for example a station having only three 40-light dynamos of about 2,000 volts and 10 ampères each. By coupling these in parallel we would obtain a current of 2,000 volts E. M. F. and 30 ampères. This current from 6 A. M. to 4 P. M., or 10 hours, could be used to charge a battery of 1,000 storage cells, delivering to each cell 30 ampères for 10 hours; that is, 300 ampère hours. Now, at four o'clock these 1,000 cells which have during the charging been connected in series are changed about so as to be connected in 20 parellel rows of 50 cells each, thus giving an E. M. F. of 100 volts, suitable for incandescent lamps. Each of these twenty rows having a capacity of 300 ampère-hours, the entire series of 20 are capable of delivering 6,000 ampère-hours at a potential of 100 volts. Now, if we suppose that with the resistance of the circuit each lamp requires 1 ampère it follows that 6,000 incandescent lamps could be lighted for one hour or 1,500 for four hours, the maximum lighting duration established by actual experience. Thus, by the mere addition of one thousand cells to an arc light station with only three 40-light machines, we could, without the addition of any machinery whatever, by the mere adjunct of the storage-battery, furnish current for 1,500 incandescent lamps, and maintain them with the utmost degree of steadiness.

What has just been stated with regard to arc light stations is equally true of incandescent light stations. Instead of having the majority of machines idle during 18 hours out of the twenty-four, a few machines might be run continuously, charging storage batteries which would furnish the supply of current needed during the busy hours.

Such a station, the first of its kind in the world, I believe, is now in course of construction at Haverford, not far from this city of Philadelphia, and I am convinced that the results which will be obtained will justify courageous wisdom on the part of its projectors.

I believe I have shown that those principally interested in arc lighting have a number of paths open to them by which they can with profit add the incandescent light, or for that matter electric motors, to their business. I need only remind them that the street lighting, which most of them are engaged in at present, embraces only 5 per cent. of the total lighting done in this country, and that of the remaining 95 per cent., according to our present knowledge, only 5 per cent. more can be touched by the arc light. The remaining 90 per cent. must be done by incandescent lighting.

It was suggested that as Dr. Moses would speak on a kindred subject it might save time to hear him next, and have the discussion on secondary batteries and secondary generators together.

Dr. Otto A. Moses, who had recently inspected the secondary generator plant at Pittsburgh, put in by the Westinghouse Company, then gave an extemporaneous address on

SECONDARY GENERATORS.

It is necessary at the outset of the address to state some of the conditions under which secondary generators can be and must be employed. The excellent paper they had just listened to pointed out one of the great difficulties in the way of the proper distribution of electric current. Mr. Sprague yesterday spoke of the great difficulty of running electric lights and motors from the same circuit, with present distribution. Now, to distribute current from a central station means to give what is wanted when it is wanted; but as during the hours of night there is little demand for current, it is reasonable to suppose that at the time when energy is not being generated, the commercial value of the heavy investment in plant for producing current is not being utilized. He would suggest that that is the pivotal point upon which discussion must turn.

Dr. Moses then went on to point out that when Mr. Edison started his first large central station in New York, the principle was laid down that when a thing is wanted you must be able to supply it, and that there is no use in supplying it until it is wanted. He thought an error was made there, not in the principle, but in its application to the facts, for the true principle was to utilize your plant to the utmost by producing current without cessation. Now, as during the night there is little demand for current, the current in such a station would either have to be stored or not produced. But in order to make the plant really profitable the current must be produced, thus utilizing the plant to the utmost extent. It followed, too, that such current should be manufactured—and stored—in places where the investment in land and realty would be brought down to a minimum. This meant for one thing carrying the agencies of current production to the place where the chief element of production was to be found. That, however, was a matter for the future. Meantime he held that if currents of electricity are to be manufactured and handled with safety so as to take the place of other forms of energy now bought and sold, it must be delivered at low potentials where and when it is wanted in cities, but must be transmitted at high potentials from its extra-mural places of low cost production. That proposition he regarded as now self-evident, and the method for such work was to be found in the use of secondary generators. The problem was to bring currents of high electromotive force from a distance and then to transform them into currents of low electromotive force. That problem had been attacked and solved.

Dr. Moses proceeded to give a brief but very interesting sketch of the development of theory and practice in the use of induction coils, dating from Faraday, and coming down to modern work with "transformers" and "secondary generators," and he called special attention to the extraordinary fact that so long a time should have passed before any one thought of reversing the action of induction coils for practical use, so as to make the fine wire coil the primary instead of the secondary. But in 1882 Gaulard, of France, undertook to make his transformer with a fine-wire primary, and thence dated the solution of the whole question as to the transmission of electrical energy from a distance.

Coming down to the introduction of the well-known Gaulard-Gibbs system in this country,* Dr. Moses gave an account of his inspection of the plant as put in on the Westinghouse plan at Pittsburgh. There was, he said, in that alternating current station none of the paraphernalia of enormous generators, with complicated commutators, and with all the accompanying apparatus necessary to regulate the current. They had all long ago, he believed, seen that the commutator was the weak spot in the machines for the continuous current, but in the alternating machine this commutator was done away with. In the system of secondary generation, where currents of opposite polarity are induced, there was no necessity to "correct" the currents. The currents were taken directly from the collectors as they were produced, and there was no necessity to straighten them—to change their direction—by costly and intricate commutators. These alternating machines he saw were easily manufactured. All the mechanical difficulties seemed to have been eliminated. There were simply masses of iron and massive coils, and no commutator to interfere with the proper working of the system, and the result was that these new producers of current could be made at a low cost. At Pittsburgh, in fact, the whole station seemed to him to be notable for the simplicity of its details and construction. Natural gas was burned under the boilers, and the Westinghouse engine was used. In the present state of the art,

* The Electrical World, December 4, 1886.

it was necessary to use a little exciter for the alternating machine, but he wanted to be put on record as saying that the time was not far distant when this device for exciting the fields would no longer be needed. The exciter was, however, a detail of minor importance.

Dr. Moses then gave an out'ine of the familiar principles involved in the use of the convertors or transformers on the line, and pointed out that great flexibility of system was secured, so that any current of any potential and any quantity could be taken off where wanted. Moreover, he said, it will be possible to so change the direction of that alternating current as to effect electro-deposition by it; to get off direct currents from it, and, in fact, to apply it to any use for which electricity is in demand.

After asserting his belief that with the alternating current system such great powers as Niagara could be utilized, 30,000, or even 100,000, volts potential being transformed down to large quantity currents of 5,000, 3,000, 1,000 or 500 volts, he closed by a reference to the work of Rankin Kennedy and the plan of placing the transformers in multiple arc.*

DISCUSSION.

Mr. MORRISON: What about the armatures of the dynamos?

Dr. MOSES: The armature is one of exceeding simplicity. I saw them working right straight along, and if the thing works well once, there is no reason why it should not work well twice.

Mr. MORRISON: Does it wear out?

Dr. MOSES: There is nothing in it to wear out. There is metal in it, but that does not wear out; it is simply a question of making dynamos with proper insulation.

Mr. MORRISON: Well; but does the insulation stand?

Dr. MOSES: From the nature of the construction of the machine, I should say admirably well.

Mr. MORRISON: But does it stand? How long has the apparatus been in operation?

Dr. MOSES: There is a gentleman here from Pittsburgh, Mr. Duncan, who is largely interested in electric lighting there—and, by the by, if you will let me say it, when I was in Pittsburgh I visited his central stations, and very remarkable stations they are, like cocoons, one within the other. Mr. Duncan has investigated this subject, because, as I understand it, he has the complete control of this Westinghouse system in Allegheny county. He would, therefore, be the most proper person to speak about these questions of operation. As regards durability, beyond the mere theory of the matter, I must refer you to him.

Mr. MORRISON: The only reason I have in asking these questions is that you have made specific declarations with regard to the value of this system, and that I want to find out just what you have to base that upon.

Dr. MOSES: I have had correspondence on the subject, and I find that so satisfactory is the secondary generator system at present that they are introducing in Rome a central station that will distribute to 20,000 incandescent lamps, and provision has already been made for 6,000.

Mr. MORRISON said that he was after material facts and did not want to have the members blinded by the brilliant oratorical effects of the speaker. He wanted to determine the value of the thing. They had seen grow up among them a whole lot of promising electrical schemes, and they had found that when applied, many of them did not yield the results that had been expected. Now in the case of these converters, what facts had they to go upon? How long had they been in service? What results had been obtained? Did Dr. Moses ascertain on the spot, from personal observation, the life of the apparatus and its efficiency? The life was one of the main questions. If the life was short, then there must be frequent renewal, as in the case of the storage battery.

Mr. WEISSLEDER wished to know whether that form of current could not be in some way utilized for storage battery purposes.

Dr. MOSES replied that such a plan was possible and probable. They might, he thought, do what they pleased with it—get secondary, tertiary, fourth and fifth inductions with it, the only question being as to economy with each transformation. The loss would be in each from 1½ to 2 per cent.

As to the conditions under which the apparatus worked, he could only tell them what he saw. He saw the conductor running 1½ miles from the station—making 3 miles of circuit—and they were operating on it incandescent lamps in the stores along it. They were selling those lamps in Pittsburgh, the home of natural gas.

Mr. MORRISON expressed some very decided opinions against the value of natural gas as a safe agent, and against its merit as a competitor in lighting.

Dr. MOSES remarked that not only was Pittsburgh the home of natural gas, but that it was built on magnificent coal deposits. Yet instead of using gas, the people were buying the incandescent light. South Pittsburgh, where this system was in use, he should look upon as a rather poor locality. There were not many fine stores in it. It was narrow, the worst condition, as Mr. Sprague had said, for such distribution; it was long drawn out, and not linked sweetness by any means. It went out in one direction between the river and the hill, indefinitely, and yet along that strip they distributed from their lines. It was the worst condition possible for the distribution of incandescent lights.

Mr. MORRISON wanted to know whether the light was taken in that locality because it was better than gas or because it was cheaper. In Baltimore gas was 60 cents a thousand, yet his company sold lights, and at a fair price, because the light was better than gas, because the air was purer, and for all the sanitary and other reasons.

Dr. MOSES said they had on the floor the representative of a firm which had been instrumental in putting in that plant, and he presumed that gentleman could give them some facts as to cost, etc. As for himself, he could say he had seen the plant working smoothly, with self-regulation, from the boilers up to the alternating current machine and the transformers. He saw but very slight movement of the voltmeter, because the current was kept so very uniform; and he saw but one man about the whole station.

Mr. MORRISON persisted in his close interrogatories, and elicited the information that the oldest plant of the kind in Greensburgh had been in operation two months and a little over, and that the other one, from which all those stores were lighted had been in service a little over two weeks. That ended his statement of the case.

Mr. W. C. KERR, speaking for the Westinghouse system, said he was very glad to be given the opportunity to dwell on the commercial aspect of the case. He and his associates had had a great deal to do with the introduction of new things, and in fact had done nothing but develop something new. There was always a great deal of misunderstanding, a great deal of doubt, to contend with, and at the same time an undoubted desire for information. That information could not always be given in a breath. Some of Mr. Morrison's questions, for instance, were very hard for Dr. Moses to answer. Dr. Moses, as a scientist, had examined certain apparatus and had arrived at some very conclusive impressions regarding it, as they could see from his remarks; but it was not to be expected that he would be ready to answer such questions from the commercial standpoint. As to the point of durability, it could be said that the system was not fully developed, so that any man could guarantee it for, say twenty years. It was simply in the condition that all new things are. Various machines have been built. The system had been put in in various places, and time must elapse in which people could form their opinions. Without intending to make any advertisement of the system, he would mention the places where the system was in operation, and where lights were being rented. There was one at the South Side, Pittsburgh, which Dr. Moses mentioned, one at Greensburgh, Pa., one at Carbondale, Pa., one at Plainfield, N. J., and one at Buffalo, N. Y. A small one at Torrington would be in operation in two weeks, so that within the present spring any one near any of those places could see them in operation, and form their own conclusions. One thing he would say: In building certain new apparatus, one could observe what relation it bore to other things known to work successfully; and reasons or deductions could be formed which could not be proven in a day or a month. That was the condition the system was in at the present time. It was working. It was running successfully. The test could be made by a visit, as well as by seeing other things which it resembles or which it supersedes to a certain extent. Thus they might make the comparison between the Westinghouse three wire station on Sansom street, running about 2,300 lights, which they had visited the night before, or the station at Trenton, and then go to Plainfield and notice what the station apparatus was there, and the nature of the attendance upon the station. That was a better demonstration than anybody could stand on that floor and give. It was very difficult when a thing was new and had only been before the public three or four months, to make specific statements, by which any one would care to be bound. He thought that by the time the association visited Pittsburgh, they would be able to see a great deal of the system for themselves.

Mr. MORRISON: That is what I wanted—to do away with the idea that this problem was absolutely solved.

Mr. C. P. CURTISS: I was in Pittsburgh about a month ago, and I investigated this question then. A gentleman there who stands as high as any on this question told me that of his own positive knowledge six or seven armatures had been burned out in one machine inside of 30 days. I would like to ask Dr. Moses if he had any points in that direction.

Dr. MOSES: I passed about half a day in the station. I looked everywhere that I was permitted to look. I had also, I am very glad to say, an opportunity, in the enormous factories of the Westinghouse Company, to see all the details of construction. Perhaps for that reason I should be guarded in what I say, because I know that in such large establishments there may be things going on which should not be spoken of. As far as the armatures are concerned, I had the privilege of seeing them manufactured, from the first stages up to their completion. I have had some experience in making dynamo machines, and I do not see why they should there continue in certain grooves of systematic manufacture, as they seem to if those machines were burning out so rapidly. It seems to me that I would "swap horses" if my armatures burned out six a day, or a week, or a month. But they appeared to be making the armatures in a regular systematic way, just as all of Mr. Westinghouse's machines and appliances are manufactured.

Mr. DE CAMP said that this system appeared to be an old thing recently renovated, and there must be some suspicion as to the merit of it, or else being so long known, it would have been more generally utilized. One of the objections he had heard was on the score of safety. Then he wanted to know what was its economy, what was the loss in induction. One gentleman had said to him that if those wires were run in front of an iron building it would create induction and loss of current.

Mr. SLATTERY regretted that Mr. Moses had made an omission of everything that could really guide them in determining the commercial efficiency of the system. He also took exception to the statement of Dr. Moses that prior to the work of Gaulard and Gibbs, no coil had been made to transform high tension into low tension current. The very coil of Faraday that the Doctor had referred to was composed of about No. 14 B. & S. gauge, and he believed that the primary and secondary wires were neary identical in diameter and in number of turns, which after all were factors that would give them the necessary conditions in a commercial system of illumination if placed upon a multiple arc circuit or on a series circuit such as the Gaulard and Gibbs. That was to say, if they passed 10 ampères through that primary—and No. 14 B. & S. had a perfectly safe carrying capacity for 10 or 12 ampères—they would get commercial results in the secondary circuit, or, in other words, they could operate incandescent lamps. Although he wanted precise information as to this particular system, Mr. Slattery said there was no doubt at all about the fact, as a fact, that the transformation from high tension into low tension could be done efficiently.

Mr. DUNCAN, after taking occasion to protect the good fame and character of natural gas as used in Pittsburgh, went on to speak of the work he was doing in supplying incandescent lights there, and of the reasons why that light was preferred there, as against cheap gas of any kind. Hitherto, he said, that they always had a very dirty city, except during the last two years, when they had brightened up a little. It had been a city of gloom, heavy fogs, etc., but the gas had been very poor. Latterly, owing to the competition, however, the gas companies had been stirred up, with the consequence that they got a very excellent quality of illuminating gas now at from 80 cents to $1 per 1,000. But the people preferred the incandescent light. It was easily handled. It could be placed in their stores and in their rooms in just such a way and position as they desired; it could be easily controlled, and the handiness of the switches, etc., made it more accessible and less troublesome. In the next place, it was a cleaner article than gas. All these and other reasons might be given for the very general introduction of the light in that city. They were now wired up for 3,000 lights more than they could supply, because they had been reconstructing their station, and were not quite ready with their power. With regard to the alternating current system, he simply wished to say that the Allegheny County company was not at present operating that system. The Pittsburgh Light Company, organized and operating on the South Side, was using the system with machinery, which had been in operation there for two weeks. They were running about 600 lights, distributed over about 1½ miles of territory in length, confined between the Monongahela River and the hills, a very narrow strip of land, being only two streets wide, but opening out above Twenty-sixth street. There they got more territory to cover, but the light was now principally confined to two main streets and the cross streets, between Eighth and Twenty-sixth. It was pretty hard to say after two weeks, as to the economy of the system, or as to why one armature burned out, or a dozen. It was not so long ago, as they knew, that arc light machines burned out when insulated with paper. That question, anyhow, it seemed to him, ought to be left out. It was not a fair matter of discussion before the convention. But there was the Greensburgh plant. He had been told by Greensburgh people that some armatures burned out, but he had also been told by the engineer in charge of that station that an armature in one of the machines had been running for four weeks consecutively; and he claimed that an armature running four weeks would run indefinitely. It was a problem of mechanical construction, and he did not think it entered into that discussion at all, and he did not see how any question of burning of armatures could militate against the proper consideration of the system. As for himself, when he first looked into the system, he did not think very favorably of it, but after several visits to Greensburgh, and after seeing the operation in that South Side station, where everything was running smoothly with 600 lights and the regulation in the station was as close as 2½ to 3 per cent., he had begun to think that there was a very great future for it, and he could not see why there should not be. He invited the members to correspond with him on the subject, promising to give them any information he could. All he could state now was that the system had not been sufficiently developed for any man to speak as to the relative merits, in dollars and cents.

Mr. POWERS pointed out that under any conditions, to carry a current any great distance, whether it be alternating or direct, there must be a percentage of loss, and practically the loss in each case must be precisely the same for the conveyance of the current. With the alternating current they gained flexibilty of system and paid for that the cost of conversion. As to the question of danger, he had had some experience with alternating current machine manufacture, and knew something about the effects of the alternating current upon the human system. Those effects were extremely unpleasant. He would rather take a sharp shock from a direct current of 1,000 volts than from an alternating current of 500 volts. Mr. Powers also suggested that there would be danger of accident if any one in a building were to stand on a radiator or something of that kind and as one might unthinkingly take hold of the secondary connection of the lamp or lamp holder. Would there not be extreme danger of a current of that potential destroying the insulation? Would it not be tempted to produce fatal results there? That struck him as the most dangerous aspect of the case, as fires might be produced in that way.

Mr. KIMBALL: I should take pleasure in answering the two questions, and I would like to read two or three notes that may have a direct bearing on this question.

DISTRIBUTION BY ALTERNATING CURRENTS.

As the question of electrical distribution by means of alternating currents and the further medium of transformers or induction coils has been brought so prominently before this Association, a few words upon the immediate possibilities of this system will be of interest.

In 1877, Prof. Thomson, now of the Thomson-Houston Electric Company, of Boston, delivered a lecture and, among other things, proved to his audience the reversibility of the induction coil and also that a discharge of static electricity was identically the same as that of a continuous current from batteries. One of his experiments was the passing of a current from several gallon Leyden jars through the fine wire of an induction coil or its secondary circuit, as it is more commonly designated; the *ends* of the coarse wire or *primary* coil, having been previously brought into slight contact, a bright spark and a fusion of the wire ends resulted, sufficient to cause the terminals to stick together; thus at that early day giving a forecast of the method of electric welding which has since been developed into a practicable electro-mechanical process. Experiments were carried on by Professors Thomson and Houston during 1878 and 1879; coils of insulated copper were made of a hoop shape and wound over with an iron wire sheathing.

This, of course, was before the incandescent lamp had been brought to a suitable condition for commercial use. Since the production of the incandescent lamp, these researches have been extended with a view to developing a complete system to meet the requirements of long distance transmission of electrical energy. How successfully must be demonstrated by the apparatus itself. I may, however, briefly mention a dynamo machine which is self exciting and automatic in its regulation for any number of lamps turned off or on up to the capacity of the machine, delivering a current alternating in its direction through the line, and, upon such a circuit—in which the usual form of electro-magnet reacts upon itself to such an extent that its temperature may be raised to the melting point — apparatus has been devised having all the properties of electro-magnets, giving a push or a pull proportionate to the current expended, thus enabling the construction of direct reading voltmeters and am-meters, arc lamps, the running of specially constructed motors for the distribution of power, and still further the operation of plating machines and of electrical devices for measuring the alternating impulses given to the line, all being supplied from the same wire. Safety devices are used which make the danger to life and property no greater in the building or residence than with the low tension dynamo of 100 volts difference of potential with which we are familiar. Still more, it has been demonstrated that although the wiring of this system follows the laws of multiple arc conductors and points widely separated are subject to a rise or fall in their E. M. F., that a means is at hand for equalizing these

*THE ELECTRICAL WORLD, Jan. 15, 1887.

discrepancies in such a manner as to maintain the entire network in constant equilibrium at an even difference of potential at the poles of the lamp under great changes in the number of lamps connected, and while not *necessarily* depreciating apparatus, we have opened up an immense field of incandescent electric lighting at a distance from the central station.

Mr. CARL HERING rose to correct an impression that had been formed as to the apparatus shown at the Franklin Institute by him on the previous evening and about which he had remarked that the coil used would disintegrate quickly. It was the Zipernowski-Deri, whereas the Westinghouse coil, as they all know, was the Gaulard-Gibbs. He also called attention briefly to the work of Mr. Gordon in England..

Mr. WEISSLEDER moved that a committee be appointed to report on secondary distribution at the next meeting of the convention.

Mr. DECAMP asked as to potential used in Pittsburgh.

Mr. DUNCAN : About 1,000 volts.

Mr. DE CAMP : Are the converters put inside or outside the building?

Mr. DUNCAN : They are in most cases placed upon the poles between the two cross-arms ; and in another case, where there is a distribution of 250 or 300 lights, I understand that they have put the boxes inside the building in the cellar.

Mr. DECAMP : They put them on the poles because it is objectionable to put them inside.

Mr. DUNCAN : As I understand it, it is a matter of convenience for distribution, for the reason that if you take the ordinary store such as we have to deal with on the South Side, they only require on the average fifteen 16 c. p. lights ; and as the poles are, I presume, about 140 to 160 feet apart, it is a matter of economy to place those converter boxes upon the poles and thence to distribute to either side of the streets, running off lines accordingly. The place where there is a distributor in the house is in a public building, of about 250 lights. They put a converter in that case in the second story of the Market House as a matter of convenience for distribution.

The following committee on secondary distribution was then appointed : Messrs. Weissleder, Slattery and Carl Hering.

An interval in the discussion on secondary generators was occupied by Mr. C J. Kintner, examiner of the U. S. Patent Office in Class Electricity. Mr. Kintner dealt briefly with the subject of

PATENT OFFICE REFORM.

He wished to make some extenuation of what Mr. Steuart had reported, while heartily commending the report and the efforts that gentlemen outside the Patent Office were making in the direction of reform. He wanted them, however, to appreciate the difficulties of the position in which he was placed as a public officer in carrying out in anything like a successful manner the business of properly examining the applications which came before the Patent Office. He professed to be perhaps as well prepared, theoretically, as most of them, to cope with the technical questions arising, but he was without the apparatus that any well organized institution like the Patent Office ought to have. To-day they had in that office a laboratory the total material of which cost less than $500! A little over a year ago it became his privilege as chief of the electrical division to recommend to the commissioner of patents a system which, in his opinion, would put the experts of the patent office upon a par with those outside in every respect. He recommended in his report that a central plant be stationed within the court of the building, that a workshop should be organized, and that a system of heating and lighting the building be combined there, by which it would be possible to light and to heat without any other expense, and the apparatus would pay for itself. No progress had yet been made in that direction, however, and, in fact, if they would look back through the reports of the commissioner of patents they would find the same old story regularly repeated of want of room, want of force, want of everything which would go to make a complete system of examination of patents. Yet they did their work in a creditable manner, turning out patents of which he ventured to say that four-fifths would be sustained by the courts. It was marvelous how they did it.

M. Kintner then called attention to the fact that the rapid development of electricity had necessitated the division of his department into two sections, and urged that the whole matter of reform and attention to wants, as suggested in Mr. Steuart's report, lay in the hands of the members themselves, as inventors or users of patented apparatus. He also considered the suggestion as to the patent court as eminently proper. The present system of appeals, too, was, to use a vulgar but pithy expression, "tail-end-to." The examiner in charge of a division is an expert upon the merits of a case, and he is appealed from to the board of examiners-in-chief, of whom, it might be said, without any disrespect, that they were not experts in that special line any more than in the other 26 arts, as represented in the divisions of the Patent Office. Thence appeal lies to the commissioner of patents, who necessarily an able man in the law, does not pretend to be an expert in those technical branches ; and from him to the District Court of the District of Columbia, and by appeal in equity to the Supreme Court of the United States. It would, therefore, be a proper course to pursue to provide such a patent court, to sit in judgment upon all disputed cases, all matters as to the merits of the cases, and all questions of infringement, so as to get unanimity and uniformity of decisions. Mr. Kintner closed by saying that he did not speak selfishly for himself. He did not expect to remain in the office another year, and was all the time in receipt of tempting offers to leave. The fact was that the personnel was constantly changing, because of the inducements from outside. While the changes he asked for would not benefit him now, they would do good to the office, and to inventors in the future.

The PRESIDENT then introduced to the meeting Mr. Ichisuki Fujioka, M. E., of Tokio, Japan, who was warmly received, and then read the following paper :

A SHORT SKETCH OF THE PROGRESS OF ELECTRICAL ENGINEERING IN JAPAN.

My present visit to this country with Mr. Yashima, President of the Tokio Electric Light Co., Japan, is to investigate the different systems of electric lighting and electric transmission of power which are now in actual use here, so that we might introduce to our country the best and most reliable system, and not to make advertisements of our work, if any. I am not well prepared to give you any clear sketch of the progress of electrical engineering in our country, and I think this short paper, which I have the honor to read now before such a remarkable body of electric men as the National Electric Light Association, would be nothing but curiosity to you.

To begin with the electric telegraph, the first line was put up in 1869, if I remember right, with Breguet's A. B. C. instrument. Since then many improvements were, of course, introduced and now nearly all the towns, small or large, are electrically connected, so that we can telegraph from any part of our country to any part of this country or anywhere else ; only it is rather expensive—*i. e.*, about $2.80 per word from New York to Tokio. The instruments we use at present are mostly Siemens' Morse ink writers, and the wires are all overhead, except some wide rivers and straits, where, of course, subterranean cables are used. The Japanese telegraphs are completely under government control.

It was in 1872 that the Imperial Engineering College was instituted in Tokio and Prof. W. E. Ayrton, the well-known electrician, now in London, occupied the chair of the professor of telegraph engineering and natural philosophy, and stayed there for six years working in the line of electrical researches with Prof. John Perry, then professor of mechanical engineering in the same college : these two gentlemen's names are pretty familliar to you, I guess, from their valuable labors in relation to electrical engineering and the ammeters and voltmeters of their invention. Mr. Thomas Gray, assistant to Sir W. Thomson, then stayed with us in the college for about three years, and I have been connected with the college for a number of years, attempting to keep up with the progress of electrical applications abroad. I was here in 1884 when the International Electrical Exhibition was held in this city.

The telephone business is yet quite poor in our country, only the government offices and residences of high authorities are connected. Petitions for permission to organize telephone companies on exchange systems are made from time to time, but the government does not permit it for some reason or other which I cannot tell. I believe, however, it will be permitted sooner or later.

Now as regards electric lighting, we have the Brush arc lights in some factories, mills and dockyards, and the Edison incandescent lights in some places; and among others may be mentioned 500 lamps in the Osaka Cotton Mill and 330 in the Imperial Military College.

On many occasions, such as at the ball of the Minister of Foreign Affairs Department, on His Majesty the Emperor's birthday, *i. e.*, Nov. 3, at the opening ceremony of the Bankers' Meeting Place, and the like, we put up temporary plants with good success, and the result of this, together with the most satisfactory reports on the Edison incandescent lighting in the Osaka cotton mill and the Official Gazette printing office, induced our people to favor the electric lighting with great eagerness. The Tokio Electric Light Co., which was organized some time ago, and of which Mr. S. Yashima (now in this room) is the president, has a capital of $200,000, and by the end of this year this capital will be doubled. The company has in hand the contract for lighting the new imperial palace with 2,000 incandescent lamps and 100 arc lights from the company's central station just outside the palace ground, and from which the current will also be supplied to the residences of the princes and ministers and other houses around it. It is proposed to place 5 or more central stations in the city of Tokio, 2 in Osaka, 1 in Kioto, 2 in Nagoya and other places. Considering the fact that the city of Tokio is 10 miles square, with a population of 1,000,000, and that there is now only one gas company charging $2.50 per 1,000 cubic feet of gas, and having old-fashioned gas furnaces, the Tokio Electric Light Company has a great deal to do towards the illumination of the city.

In conclusion, as there are many printing offices and small factories all over the city using at present numerous men or steam engines ranging from ¼ to 20 horse-power, the electric motors will also, without doubt, find good places there. I hope, gentlemen, I will be able to read a better paper when I see you next time.

Mr. WEEKS then expressed the pleasure felt by the Convention in listening to the address, and said : "I am confident our friends abroad in the electric lighting business are pretty well assured that we have the deepest sympathy with them, and entertain toward them the most kindly feelings."

Messrs. Fujioka and Yashima were then elected honorary members of the Association.

Mr. YASHIMA, President of the Tokio Electric Light Company, responded to the compliment.

Mr. WEISSLEDER, chairman of the committee on nominations, having reported, the following officers were unanimously elected: President (third term), J. F. Morrison ; Vice-Presidents, E. R. Weeks, A. J. DeCamp ; Executive Committee, F. A. Gilbert, chairman, G. S. Bowen, F. Ridlon, S. Holbrook, Otto A. Moses, E. T. Lynch, Jr., and J. F. Noonan ; Treasurer, C. Cooper.

Mr. MORRISON, on resuming the chair as president, said that for any man to declare that it was not an honor to be elected to the office would be saying what was not true, and the convention would not believe it. It was an honor, and one which he fully appreciated. At the same time, he did not believe that the Association acted wisely in re-electing the old officers year after year. He accepted the office with the hope that the same good will and kindness that had been shown toward him in the past would still be extended.

The next question being as to the place of meeting in the summer, Mr. Upton said he had been requested by Mr. Barton, of the Thomson-Houston Company, to suggest Boston.

The same suggestion came from Mr. F. A. Gilbert, president of the Boston Electric Light Company.

Boston and August were the place and month then chosen.

Mr. DUNCAN called attention to Pittsburgh as a good meeting place one year from this time.

No further business being presented, the Convention then adjourned.

THE EXHIBITS.

As usual, the exhibits at the convention formed a most interesting part of the meeting, and a stranger drifting into the Hotel Lafayette would have imagined himself in an electrical exhibition in full blast.

The Baxter Motor Company, of Baltimore, exhibited a number of their machines in operation. They ranged in size and power from one driving a sewing machine to that driving a pressure blower. The exhibit was in charge of Messrs. Baxter, Kielholtz, McCoubray, Evans and McDermott, and created considerable interest among the members of the Association. These motors are reported to have a very high efficiency, and to be in great demand in Baltimore.

In the same room the Sun Electric Company, of Woburn, Mass, exhibited its incandescent lamps, which received current from an arc circuit, and connected to a distributor. Messrs. Fred. Swift and M. M. M. Slattery had charge of the exhibit.

A large variety of fancy globes for incandescent lamps were also on show there, being the product of the works of Mr. H. G. Osterle, of Philadelphia, Pa.

In the rooms of THE ELECTRICAL WORLD the Schuyler Electric Light Company exhibited one of its 65-c. p. incandescent lamps, run in series on the Brush 10-ampère circuit, and in an adjoining room the same company exhibited in operation a distributor for running incandescent lamps in multiple from arc circuits. The series lamps are manufactured with the cut-out within the glass globe, so that the breaking of filament causes no interruption to the circuit. The device employed for the purpose consists in attaching the terminals of the filament to strips of copper separated by a sheet of mica. When the filament breaks, the arc formed travels down until it reaches the copper strips. The intense heat fuses them together and thus forms a path for the current, which is thus preserved intact. The experiment of breaking the lamp and admitting air to the filament was tried in our presence, and the action was seen by us to be a reliable one, the lamp arcing until the fusion of the copper strips formed a new path for the current. Messrs. H. M. Linnell, J. A. Dalzell and Mr. M. J. Wightman had charge of this exhibit.

Mr. H. B. Cram, who had charge of the exhibit of the Berstein Electric Light Mfg. Co., of Boston, showed the latest form of lamps and cut-outs of that company. The cut-out for two lamps is a very neat and compact arrangement, and the combination of lamp, reflector and cut-out is very well conceived.

One of the most interesting exhibits was that of the C. & C. Electric Motor Co., of this city, under the charge of Messrs. S. S. Wheeler and H. L. Lufkin. A small shirt and shoe factory had been improvised and half a dozen sewing machines were kept in constant operation by as many girls. The machines were driven from the arc current. The company also exhibited its large half-horse-power motor belted to a ventilator fan which it drove at full speed. The exhibit was a very creditable one to the company and was well attended.

The insulated wire exhibits were quite numerous. The Okonite Company, of this city, had a large variety of its wires on show, and distributed sample cards of its manufactures. Mr. Willard L. Candee and Mr. G. T. Manson had charge of the exhibit.

The Standard Underground Cable Company's exhibit of the Waring lead-covered cables was in charge of Mr. George L. Wiley, and the various sizes and styles for underground and interior work attracted considerable notice.

The Callender Insulating and Waterproofing Company had on view a complete line of their insulated Bitite wires for all classes of work, Messrs. W. M. Callender and A. W. Butterworth being in charge.

The samples of Mr. A. G. Day's kerite wires were exhibited by Mr. C. B. Hotchkiss and Mr. R. W. Pope. We ought to commend the prominence ingeniously given in the meeting-room to the Kerite sign. Among the collateral exhibits was that of Pittsburgh Carbon Company, in charge of Mr. George F. Porter. The National Carbon Company, of Cleveland, O., also exhibited a large line of their products, which were explained by Messrs. W. A. Lawrence and C. D. Smith.

Mr. E. F. Gennert exhibited glass globes of all varieties and shades and reflectors for incandescent lamps made by the E. P. Gleason Manufacturing Company, of New York.

Electric light hoods, both for arc and incandescent lamps, and a nest of district telegraph drawers, were shown by Mr. A. K. Watt.

A very neat set of testing instruments, adapted for the testing of electric light and other lines, was shown by Mr. Frank Stewart, of the Western Electric Company, of Chicago. It contained twenty-five cells of silver chloride battery with the requisite resistance coils and galvanometer.

The Edgerton Electric Motor Company exhibited at their offices, northeast corner Market and Thirteenth street, an electric railway in operation, together with their motors doing various kinds of work. Many members availed themselves of the invitation extended by Prof. Edgerton to the convention.

The wonderful properties of the anti-magnetic watch shield were explained by Mr. C. K. Giles to many of the Convention.

The Elgin telephone was also on exhibition, connected to a short line; and through the kindness of the American Telegraph and Telephone Company the members were able to converse with their friends in New York, Brooklyn and vicinity, a long-distance telephone set having been provided and placed at the disposal of the members, free of charge.

The insulated pliers for the use of linemen and others, made by Messrs. J. H. Bunnell & Co., of this city, also attracted some attention from those present. The handles are thoroughly insulated by a coating of rubber and rubber tape.

Current for the various lighting and power exhibits was supplied from the Brush circuits, under the supervision of Mr. M. D. Law. The work was done with admirable care and thoroughness.

NOTES OF THE CONVENTION.

A large number of the members availed themselves of the invitation extended by the Franklin Institute for the stated meeting on the evening of Feb. 16, and the lecture hall was crowded to its utmost capacity. After the transaction of miscellaneous business, Mr. Pedro G. Salom read a paper on "The Julien System of Electric Transmission," in which he described the methods pursued by M. Julien and the practical results. In the course of his lecture Mr. Salom said: "In taking up the theoretical aspect of the case, I believe that the conscientious study of the chemistry of the galvanic battery, and more particularly of the storage battery, will help us materially in forming a correct scientific conception of the nature of electricity. The latter is approaching so closely to the domain of chemistry that the border line is becoming more and more indistinct, and it is a question now whether electricity will absorb chemistry or chemistry devour electricity. As it is a fundamental maxim that we can create neither matter nor force, and as heat is the sensible result of chemical union or combination, where does this energy come from? Manifestly from the atoms taking part in the reaction. May not electricity under certain conditions be the result of chemical disunion, decomposition or molecular transposition? Of course we understand that an amount of energy must be absorbed by chemical decomposition, equivalent to that developed by chemical combination. But in the galvanic battery there is a double of combination and decomposition in which the energy does not appear and disappear as heat, but under such conditions manifests itself as an electric current. In other words, electricity is the mechanical expression of chemical affinity, or the force of chemical attraction. I mean by that that the mysterious force that holds an atom of hydrogen to an atom of oxygen will, when those two atoms are separated under certain conditions, manifest itself in the form of an electric current and that the amount of current developed will be directly proportional to the number of atoms involved in the reaction, and the intensity of the current or electromotive force to the chemical affinity they may have for each other. That this idea of the chemical basis of electricity, if I may be permitted to term it so, is becoming more and more general, is evidenced by the works of Faure and Silbermann, Andrews, Thomson, Berthelot and others, and Mr. John T. Sprague, in his great work on electricity, has done for it what Joule did for heat." Mr. Salom then sketched a short history of the secondary battery, the difficulties that had been met with in the older forms and the recent very successful work of M. Julien, whose results ascribed to the inoxidizable support plates for the active material employed in the Julien battery.

The hall of the Institute was lighted by incandescent lamps fed from a set of Julien storage batteries placed on the floor near the lecturer, and the battery plates in their various stages of manufacture were also on exhibition and were eagerly inspected by the audience after the lecture.

After Mr. Salom had finished, Mr. F. E. Ives, of Philadelphia, gave a lantern exhibition of photographs taken by phosphorescent light.

This was followed by a short lecture delivered by Mr. Carl Hering on secondary induction. His remarks were accompanied by experiments with an induction coil wound according to the method of Messrs. Zipernowski and Deri. The alternating current was supplied by a small Gérard machine. The latter, originally a continuous current machine, had been changed by Mr P. H. Richardson, electrician of Messrs. Queen & Co., into a machine giving both continuous and alternating currents; the former for the maintenance of the field. Mr. Hering showed the small quantity of current in the primary coil by inserting in the circuit a piece of fine German silver wire, which remained intact. On interposing the same wire between the terminals of the secondary it was immediately fused. Seven such wires placed simultaneously across the same terminals were also brought to vivid incandescence and finally fused; an iron nail was similarly experimented with, showing that the current in the secondary must have been many times greater in the latter than in the primary.

During the proceedings Dr. Wahl took occasion to remark on the presence of the members of the convention, and upon his concluding, President Morrison replied as follows: "I rise on behalf of the National Electric Light Association to thank you for the invitation kindly extended by the Franklin Institute to us to-night. We accept that invitation with all the more pleasure because of the many matters of an electrical character which have been scientifically treated by your body, and have gone out into the world at large and resulted in immense benefit, not only to electric light interests, but to electric interests also. As you are aware, sir, myself and my colleagues are in that branch of electricity in which it is applied to illumination and motor power; and we, as a body, heartily thank you for the able assistance you have often given us in this direction, which has given employment to many men, and, as you perceive, has enabled us to grow rich.

"We, as you know, are a traveling institution; to-day we are in the city of "brotherly love," last year in Detroit. In fact, we have been from Illinois to Philadelphia, and are now contemplating gravitating to more civilized centres, such as Boston. But if ever it is in our power to return your hospitality, I feel that I voice the sentiments of this convention when I say that nothing will give us greater pleasure. Again, in behalf of the National Electric Light Association, I thank you."

After the meeting a large number of the members visited the Keystone Electric Light Company's station on the Westinghouse system, near by, which supplies the light of the Franklin Institute. The compactness of the plant, not less than its neatness, was admired by all.

The invitation extended to the Association by the Electric Club, of New York, was accepted by a large number of the members, and a special car took the majority to New York on Thursday after the close of the Convention.

After partaking of an excellent dinner, the paper of the evening was read by Mr. Stephen D. Field, entitled "Electric Motors."

Mr. Field gave a short account of the principles underlying motor construction, and dwelt upon the necessity of having sufficient iron in both field and armature. He explained his electric street railway system with the aid of diagrams, which appeared in our last issue, and showed the advantages attending the system.

In the discussion which followed several members inquired as to the cost of the system, and Mr. Field stated that $20,000 per per mile would cover all expenses for such a conduit system.

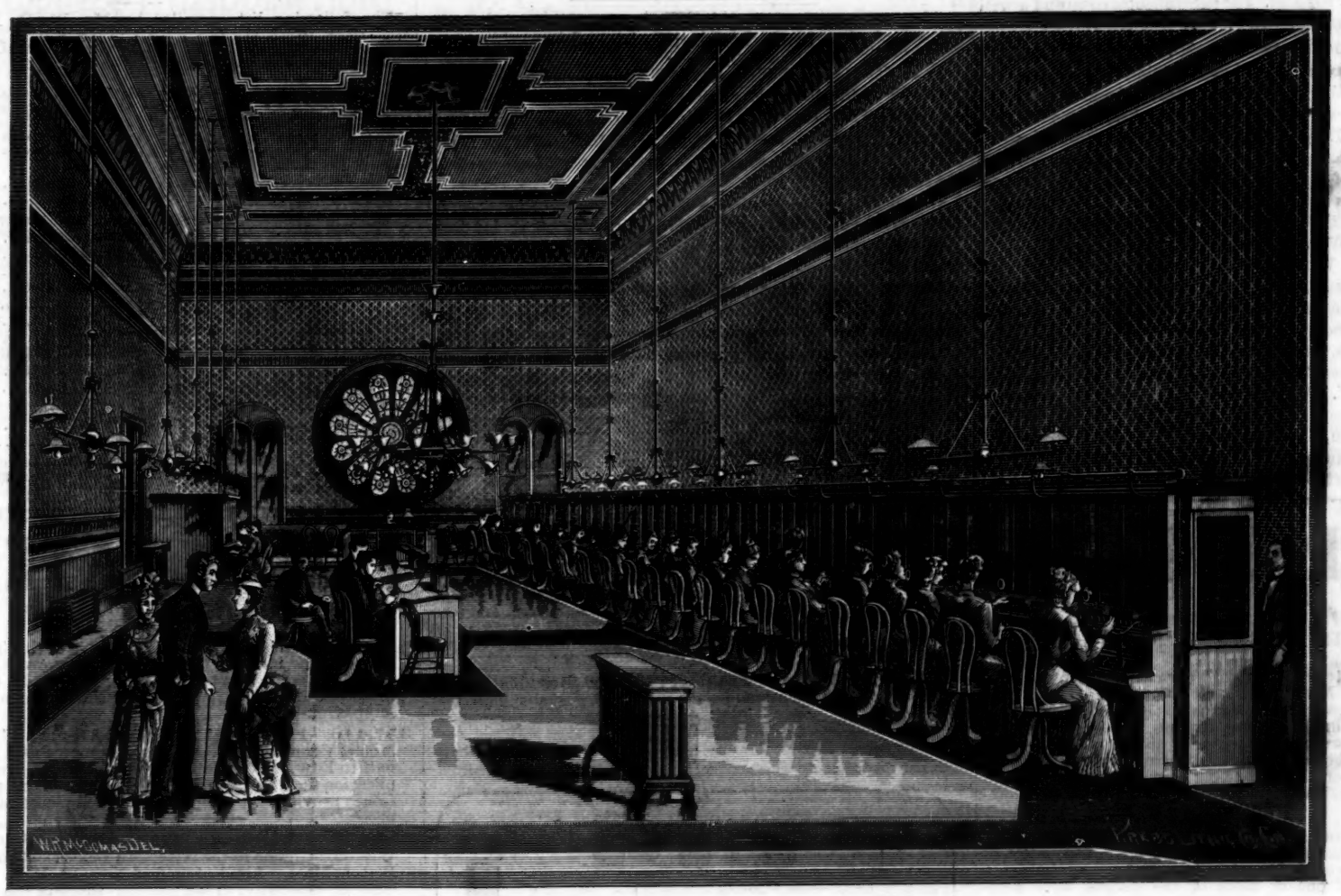
Mr. S. E. Barton, of the New England Insurance Exchange, gave a good account of the attitude of insurance companies towards electric lighting companies, and stated amid applause that properly constructed and inspected stations were considered first-class risks by the insurance companies with which he was connected.

The meeting ended with several humorous remarks, among which the definition of "electricity," given by Mr. Slattery, supplementary to definitions quoted by Mr. Weeks, from the standard dictionaries, created special merriment. A vote of thanks to the Electric Club by the members of the Association concluded a most enjoyable evening.

During the convention, THE ELECTRICAL WORLD issued its Bulletin giving the officers of the Association, the names of members and visitors in attendance, the programme, the business transacted in the meetings, the exhibits and other matter of interest. Three editions were issued, each of several hundred copies, and these were in great demand, not only for reference but for mailing. Under the circumstances, the trouble involved in getting out such a bulletin is not small, but the hearty thanks and kind words of the members have been more than a return for the work and expense thus voluntarily assumed.

The New Cincinnati Telephone Exchange.

We illustrate on this page the sumptuous new telephone exchange at Cincinnati, in which provision has been made for 2,300 subscribers. The whole work has been done under the supervision of Capt. G. N. Stone, Vice-President and General Manager of the company. In this commodious new Exchange in the Masonic Temple a scene is presented that cannot be duplicated in any other telephone exchange in the world. It is one of convenience, of luxury and of taste. On the north side of the room are seen a long line of multiple switch-boards made of mahogany and all illuminated with electric light, and all presided over by the nimble-fingered operators. Opposite the multiple switch-boards is a multiple board for toll line connections only, and on the middle of the west end of the Exchange the monitor's or chief operator's desk. The walls and ceilings are decorated with handsome paper and lincrusta walton, and the floor is next thing to a mosaic, being made of two-inch hard maple and covered with shellac. The new switch-boards are the very latest. In addition to these improvements already mentioned, the company has others still more important located in the Masonic Temple tower. On the three floors above the exchange room are the lightning arrester boards and the cross connecting boards, appointments scarcely heard of a year or so ago, and now deemed



THE NEW TELEPHONE EXCHANGE, CINCINNATI, O.

as essential to a complete telephone service as poles and wires. The company now has over 600 miles of copper circuit in use, and has replaced all its old 45-foot poles by new ones 20 feet higher. The cost of the whole work is $100,000.

Safety Circuit for Electric Lighting.

To the Editor of The Electrical World:

SIR: In your issue of the 19th inst. there appears an article written by T. J. Perrin, in which he claims (alluding to my device for safety circuits for electric lighting) that at the first glance such a method would appear an efficient one, but on closer examination it hardly appears to be at all practical, and in fact he is convinced that such an arrangement as shown would in no way fulfill the functions claimed for it. If Mr. Perrin had taken the trouble and tried my device, he would readily have seen that it performs all that I claim for it. If he has not got the facility for so doing I cordially invite him to call at my office, No. 65 Fifth avenue, where I can show him a perfect working model on a 110-volt current, which will convince him that he has made a decided mistake.

NEW YORK CITY. E. T. GREENFIELD.

The "Polychromotelepantophotophonograph."—This new apparatus, about which we published some verses lately, is now gaining fame in France, where M. Hospitalier has called attention to it in *L'Electricien*. One of our readers, on the Chicago, Milwaukee & St. Paul Railway, informs us that on a recent occasion he filled out a telegraph order, purporting to come from the roadmaster of the division, asking to have the instrument forwarded. The section foreman and his assistant on receiving the order, immediately proceeded to get out a flat car and to hunt up the instrument, when some one "gave the thing away," much to the disgust of the foreman who had spent his time vainly endeavoring to ask for that "—— —— —— electrical machine."

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
NEW YORK, Feb. 21, 1887.

The United States Electrical Company, John W. Carter, president; C. Faber, secretary and treasurer, gave a reception to their numerous friends the evening of Febuary 17, 1887, in celebration of the opening of their new store and factory, No. 529 Fulton street, Brooklyn. There were about 150 gentlemen present, who inrpected with interest a new dynamo-electric machine for incandescent lighting, a system for lighting and power by secondary battery and many other novelties. The electricians of this enterprising company pointed out the many advantages which the first-named two inventions have over similar systems now in use. The dynamo, invented and explained by Mr. W. K. Freeman, is very simply and economically constructed and allows the current to be carried a long distance without material loss, making the machine thoroughly practical for central station as well as for isolated lighting.

The accumulator, invented and explained by Dr. O. C. Flick, of Brooklyn, has plates practically indestructible, and it will hold the current with which it has been charged by a dynamo or galvanic battery for a long time without perceptible loss.

The salesroom and retail department occupy the whole ground floor of the building, and show a full supply of all kinds of electric apparatus and supplies. The engine room is an extension, and contains New York Safety boiler, steam engine and dynamos. A belt connects to the shafting on the second story, and drives the different lathes and other tools used in the manufacture of the various specialties and supplies. The experimental room and a well equipped repair shop are situated on the upper story.

The Direct Electric Fire and Ambulance Telegraph Company who hold offices in the same building, exhibited their new cal box which they are going to put out on rental, connecting to the nearest fire engine house of the district in which the protected building is situated. They exhibited also their thermostat system, by which an automatic signal is given as soon as from any cause of fire the temperature of the protected room has reached a certain degree. Both systems are indorsed by the local fire department.

Among those present were: Messrs. C. Amann, E. J. Denison, Eugene F. Clarence, Wm. J. Carlisle, J. Walsh, W. T. Hunt, of THE ELECTRICAL WORLD; I. L. Roberts, O. Koch, Geo. R. Fowler, Frederick Loeser, Chas. F. Cutler, Dr. La Madrid, Irving Burnham, ex-Judge Semler, C. Gast, Dr. Stuart, J. S. Turner, J. E. Brown, John Thompson, ex-Commissioner Witte, W. W. Browning, Dr. French, Dr. Willis, Lorin Palmer, W. U. Pastor, Dr. Wood, Capt. Tinker, Stephen J. Cox, Augustus Voege, Richard D. Owens, S. M. Wood Benedict, P. L. Watson, Superintendent Fire Department; P. W. Schmitz, F. L. Lathrop, W. Callender, C. G. Eschen, Geo. P. Hotaling, F. Overbeck, Geo. S. Lissignolo, Mr. Bonner, of Vossburgh Manufacturing Company, and Robert Courtney.

Mr. R. S. Waring, of the Standard Underground Cable Company, is preparing for a trip to Europe to look after his foreign patent interests. Mr. C. H. Jackson has been elected vice-president and general manager to succeed Mr. Waring.

The Daft electric motors are being rapidly placed in every State of the Union. The latest is an installation of several six h. p. machines running at Louis Linder's Son paper house, 21 Walnut street, and C. F. Bedley's printing house, Fourth street, Cincinnati, Ohio. The first operates two large freight elevators at a speed of fifty feet a minute, also a large paper cutter. The shafting is very long and takes considerable power to operate that alone. The motor replaced a ten h. p. gas engine, which failed to lift a load of 2,800 lbs. The second machine operates six printing presses, paging machine, stitching machine and two large paper cutters. This machine replaced a 5 h. p. gas engine which could not work all the machinery at once. The enterprise is in charge of Mr. Guy M. Gest, who was connected for a long time with the Baltimore Electric road. He reports that the parties interested in this power installation in Cincinnati are so well pleased and enthusiastic that they have decided to at once order a large number of the Daft machines.

The Daft Company are now placing posts and overhead conductor on the route of the Orange horse railroad. One car for the same is now being equipped at the Daft factory, and will shortly be delivered.

The Electric Power Company, of New York City (Daft system), are now installing a 250 h. p. Wright engine and two 50 h. p. dynamos for their New York circuit in Spruce street. The circuit is assuming large proportions.

W. T. H.

MISCELLANEOUS NOTES.

C. & C. Motor Efficiency.—It was reported in our issue last week, in the discussion on the above subject, that 45 per cent. net practical efficiency had been obtained on New York Brush circuits. It appears, however, that Mr. McGrath, of the Brush Company, making the tests, reports an efficiency of not less than 55 per cent. net.

Worse than the Boys.—A Parisian pigeon fancier saw recently a very fine female carrier pigeon hovering about his dovecote, caught her and mated her with a fine bird of his own. She remained contentedly, without being restrained, until she had raised two broods of birds, and then flew off, probably to the establishment in Belgium whose mark she bore stamped on her wings. On the whole, messenger pigeons would be a better name for these birds than carrier pigeons. Their ways seem to resemble the ways of the messenger boy. Though the latter has no wings to make use of, in the unprecedented case of his ever caring to do so, he is almost equal, in an emergency, to imitating the example of the above described despatch bearer, or of the other bird who took four months to reach Edinburgh from a suburban town a few miles distant.

BUSINESS NOTICES.

The Shafting Department of the Edison Machine Works has moved its offices and salesrooms to 19 Dey street.

The Armington & Sims Engine Co., Providence, R. I., have sold to the Edison Company and the different Edison Illuminating Companies of this system over 600 engines.

The Julien Storage System is now in successful use on the Boston & Albany road for car lighting, and contracts have been made with a number of other roads for similar work. See page xv.

The United States Electrical Company, 529 Fulton street, Brooklyn, and 41-43 Wall street, New York, calls attention on page xii. to its new system of storage batteries, as well as its motors, radiators, Carter's laryngoscope, dry batteries, voltmeters, ammeters, etc.

Jordan & Gottfried, 208 Canal St., N. Y., carry a complete stock of iron and brass machine and wood screws, bolts, cap and set screws, taps, dies, files, twist drills, brass and rubber in tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc.

H. Andres, 22 and 24 North Fourth street, Philadelphia.—The only genuine raw-hide goods made in the United States. Belting, lacing and straps of all kinds or hard raw-hide, lathes, planers, lubricators, fans, blowers, vacuum and steam pumps, cotton and leather belting, emery wheels and machinery of all kinds.

STOCK QUOTATIONS.

The following list, compiled by Mr. W. H. Baker, member New York Stock Exchange, 16 and 18 Broad street, gives the current quotations of electrical stocks:

February 21, 1887.

TELEGRAPH.	Bid.	Asked.
Am. Dist.	.....	33
Am. Tel. & Cable	70	73
Cen. & So. Am.	95	100
*Com. Tel	.....	.....
*Gold & Stock	90	100
*Inter. Ocean Tel.	90	100
N. Y. Mutual	65	70
Pac. & Atl.	47	54
*Postal T. & C.	30	35
So. th. & Atl.	60	.....
W. U. Tel.	73½	73¾
W. U. Scrip.	60	.....
W. U. Bonds	.....	120
Mut. U. Bonds	84½	85
TELEPHONE.		
Am. Bell	213	214
Am. Speaking	110	120
Erie	27⅜	27½
*Hudson River	60	65

TELEPHONE.	Bid.	Asked.
Mexican	1½	1¾
*N. Y. & N. J.	.....	93
N. Y. & Pa.	.....	.....
New England	42½	43
*Southern Bell	110	130
ELECTRIC LIGHT.		
*Am. Electric	.....	.....
*Brush	.....	.....
*Brush Ill.	.....	.....
*Consolidated	.....	.....
*Daft	.....	.....
*Edison	200	.....
*Edison Ill	105	.....
*Edison Isolated	.....	.....
*United States	.....	.....
*U. S. Ill.	95	100
MOTOR.		
*Daft	.....	.....
*Sprague	.....	.....

* These stocks are so seldom dealt in that it is difficult to give prices at which they can be bought or sold. The figures given are as near as can be ascertained.

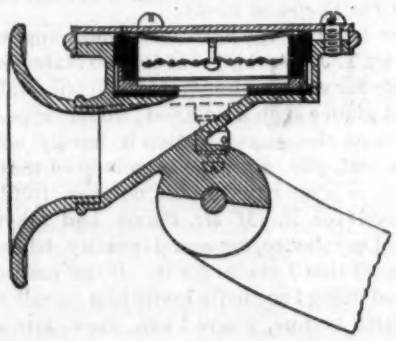
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

PATENTS DATED FEB. 8, 1887.

357,190. Life Detecting and Preserving Apparatus; W. H. Farnham, of Minneapolis, and Charles B. Askew, of St. Paul, Minn. Application filed March 22, 1886. The object in view is to provide an apparatus for use in connection with burial caskets to operate an indicator or alarm, in case there is any movement of the body contained in the casket, and to furnish a supply of air or life-preserving gas to any person who may have been placed therein in a state of suspended animation.

357,280. Electrical Distribution; W. B. Harvey, Memphis, Tenn. Application filed Dec. 15, 1885. The object of the invention is to provide improved means for maintaining a closed circuit even if one or more of the devices were accidentally or purposely cut out of circuit, and to provide in an improved manner an electric signal which will operate when one of the translating devices is cut out of circuit. (See illustration.)

357,293. Electric Cut-Out; O. B. Shallenberger, Rochester, Pa., application filed Sept. 1, 1886. Claim. In an electric cut-out, the combination of an electric circuit, contact plates connected with the ends of said circuit, a switch or circuit-closer for connecting said contact-plates, and a weight arranged to be released by a decrease in the current passing through the main circuit, and in its movement to strike the switch or circuit-closer, and thereby effect a quick movement of the switch away from the contact-plates.



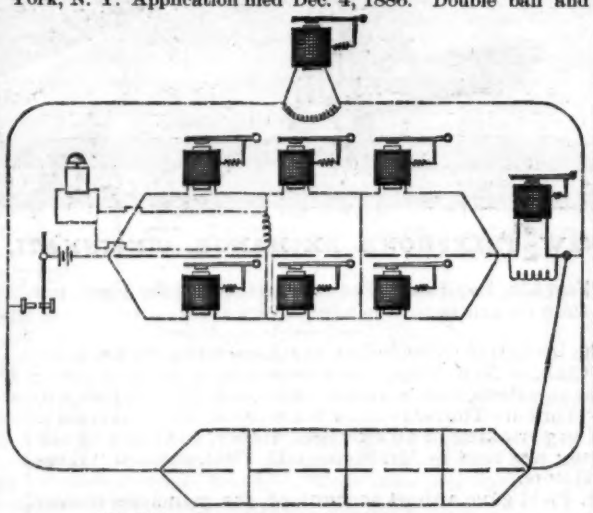
357,452. TELEPHONE TRANSMITTER.

357,295. Commutator for Dynamo-Electric Machines; George Westinghouse, Jr., and Albert Schmid, of Pittsbugh, Pa. Application filed July 31, 1886. The segments of the commutator are provided with arms for connection with the wires of the armature, and insulating sheets are arranged between the segments, which project outwardly between the arms of the segments. (See illustration.)

357,296. Electric Railway Signaling; George Westinghouse, Jr., of Pittsburgh, Pa. Application filed Aug. 25, 1886. Automatic apparatus is provided whereby danger and cautionary signals governing sections of a railway are successively set and cleared in by the passage of a train.

357,310. Instrument for Transmitting Audible Time Signals; J. R. Etter, Crawfordsville, Ind. The object is to provide a simple mechanism for automatically opening and closing a normally closed electric circuit, thereby giving simultaneously at each of a series of stations connected with said circuit two distinct kinds of signals. The mechanism is connected with and controlled by a time-piece located near the machine.

357,337. Telephone Support; Samuel Rosenblatt, New York, N. Y. Application filed Dec. 4, 1886. Double ball and



357,280. ELECTRICAL DISTRIBUTION.

socket joints are provided to allow free movement of the receiver.

(1) 357,359. Telephone Transmitter; (2) 357,360. Telephone Receiver; W. C. Barney, New York, N. Y., Assignor to Josiah C. Reiff, of same place. Applications filed Jan. 18, 1886. (1) The combination in a telephone transmitter of an air-chamber having inlet and exit openings and a continuous passage around the tympan, and a tympan located therein at other than a right angle to the path of the air waves. (2) The armature consists of a short thick piece of iron, which is secured to a tympan of wood.

357,372. Electrical Fare Box; W. A. Crowdus, Dallas, Texas. Application filed July 29, 1886. Electrical means are provided for giving notice to the driver when a fare has been deposited or when change is required by a passenger.

357,295. COMMUTATOR.

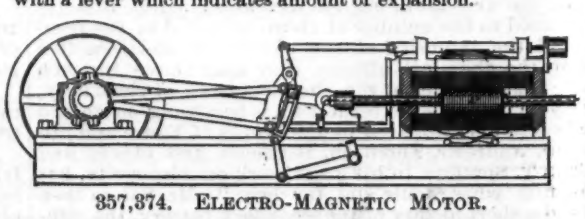
357,374. Electro-Magnetic Motor; W. H. Darling and L. Bock, Jr., of New York, N. Y., Assignors of one-third to G. P. Harrington, of same place. Application filed Aug. 2, 1886. A reciprocating motor similar in its movements and construction to an ordinary reciprocating steam engine is provided. Its operation is obvious from the illustration.

357,385. Switch and Holder for Incandescent Electric Lamps; Wm. Hochhausen, New York, N. Y. Application filed March 13, 1884. The objects of this invention are to simplify and improve the construction, prevent burning of the switch contacts, and to provide for the ready and convenient renewal of the parts, especially of the fusible safety wire in the lamp circuit.

357,416. Electrical Burglar Alarm; G. Schleicher, of Mount Vernon, N. Y., Assignor, by mesne assignments, of one-half to Edw. G. and John C. Schleicher, of same place. Application filed May 17, 1886. A curtain or piece of textile fabric provided with certain devices is placed at the point to be protected.

357,452. Telephone Transmitter; Francis Blake, of Weston, assignor to the American Bell Telephone Company, of Boston, Mass. Application filed Nov. 19, 1886. The invention consists, especially, in the peculiar shape of the different parts of the transmitter, and in the mode of combining the same with a single instrument. (See illustration.)

357,463. Thermostat; J. L. Campbell, West Elizabeth, Pa. Application filed Sept. 30, 1886. Two tubes, each carrying expanding rods secured at their opposite ends so as to expand in opposite directions are provided. The rods are connected with a lever which indicates amount of expansion.



357,374. ELECTRO-MAGNETIC MOTOR.

357,516. Electro-Magnetic Attraction Device for Cars; J. B. Atwater, Chicago, Ill. Application filed May 1, 1886. The magnets and their armatures are so arranged in relation to one another and to the current wires and conductors that when one set is magnetized the other will be demagnetized. The idea is to allow the working magnet to exert its full force without any backward draw from the demagnetized magnet.

357,538. Spring Jack Switch; C. E. Scribner, Chicago, Ill., Assignor to the Western Electric Co., of same place. Application filed Nov. 15, 1886. The invention consists of a strong and light switch, and one that is accessible for repairs, at the same time occupying but a small space on the switch-board.

(1) 357,539. Metallic Circuit for Multiple Switch-Boards; (2) 357,540. Local Battery Circuit for Multiple Switch-Board Systems; J. A. Seely, New York, N. Y., Assignor to the Western Electric Co., of Chicago, Ill. Applications filed Nov. 15, 1886. (1) The object of this invention is to provide for testing at any of the switch-boards to determine whether any given line is in use. (2) The idea here is to provide circuits whereby the local batteries at the different subscribers' stations may be utilized as test batteries when the subscribers' telephones are not in use.

357,550. Galvanic Battery; Sidney A. Chase, Evart, Mich., Assignor of one-half to Wm. R. Mapes. Application filed Aug. 10, 1886. A device is provided by means of which any cell of a battery may be taken out without breaking the circuit.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patent issued since 1866—can be had from this office for 25 cents. Give the date and number of patent desired, and address Johnston's Patent Agency, Potter Building, New York.